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DISEASES OF THE EAR

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PREFACE

THE aim of this book is to give a short and practical account of the Diseases of the Ear, and while it is specially intended for those who have not had the opportunity of devoting much time to the subject, I hope that it may be of some service to the more experienced practitioner.

With the exception of plates VI and XII, reproduced by the kind permission of the publishers, Wilhelm Braumüller, Vienna, the illustrations are original and have been prepared, under my personal supervision, by Mr. Frank Butterworth, and Mr. Wilson photographer to the London Hospital.

HUNTER TOD.

111, Harley Street,
LONDON, W.
July, 1907.

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INTRODUCTION

The organ of hearing is divided into two parts :—

1. *The conductive portion* consisting of the external ear (auricle and external auditory meatus), the middle ear (Eustachian tube, tympanic cavity with its ossicles and membrane, and the antrum) and the mastoid cells ; and,

2. *The perceptive apparatus* consisting of the labyrinth, auditory nerve and its connexions with the central nervous system.

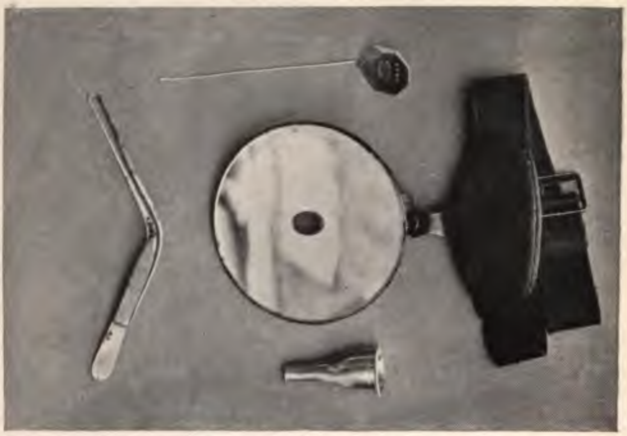
Diseases of the conductive portion form at least 90 per cent. of all the cases met with in the practice of otology.

The chief symptoms for which advice is sought are pain, deafness, discharge from the ear, noises in the head, and giddiness.

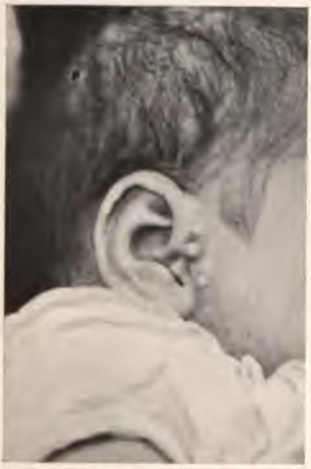
Before the actual examination of the patient, as much information as possible should be obtained with regard to the cause, onset, and duration of the disease, and whether the symptoms have been continuous or intermittent. If there is a history of nasal or post-nasal catarrh, it is important to determine whether it has any relationship with the aural affection. In cases of chronic progressive deafness in young people, and especially in cases of sudden internal ear deafness, the question of inherited or acquired syphilis must be borne in mind. It must also be remembered that, quite apart from the usual obvious causes, many other conditions may produce deafness; for example, drugs such as quinine, occupations involving exposure to loud and constant noise as boiler-making, or some lesion of the central nervous system. In cases of chronic middle ear catarrh or otosclerosis, or in supposed congenital deafness in an infant, the family history may be of assistance, not only in coming to a correct diagnosis, but more especially with regard to the prognosis. In acute affections the patient's history is usually correct; in the more chronic affections it is, however, not reliable. There may, for instance, be a complete denial of any previous discharge from the ear although inspection may show an old perforation or a scar of the tympanic membrane; a middle ear suppuration in childhood is often forgotten by the parents, unless accompanied by much pain, or profuse otorrhoea. Again, what from the patient's own account may at first seem to be an acute middle ear suppuration of recent origin, may be proved by examination to be an acute phase of a chronic condition. Similarly the patient's history is often misleading with regard to deafness. Deafness of one ear may not be noticed until the other has also become affected, and usually slight impairment of hearing is absolutely ignored. The term *deafness* is only used by the majority when the hearing has become so impaired as to cause inconvenience. Thus it is necessary in many cases to form an opinion without placing too much reliance on the statements of the patient. In every case, however,

an attempt should be made to obtain a description of the main symptoms before actual examination.

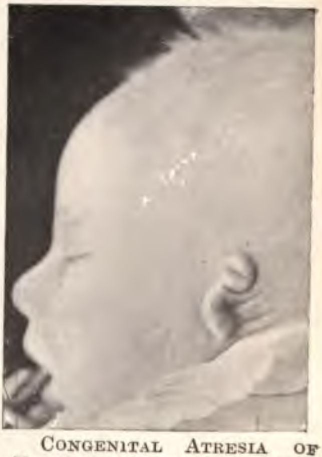
Owing to the close anatomical relationship between the ears, naso-pharynx, and nose, and to the frequency with which aural disease occurs in association with, or in consequence of some nasal and post-nasal affection, no examination of the patient can be considered complete unless it has included a thorough inspection of the naso-pharynx and nose.



INSTRUMENTS FOR EXAMINATION OF EAR.
Mirror. Probe. Aural forceps. Speculum.



ACCESSORY AURICLES
(BRANCHIAL FIBROCHONDROMATA.)



CONGENITAL ATRESIA OF EXTERNAL MEATUS WITH DEFORMITY OF AURICLE.

[*Plate I.*

CHAPTER I

DISEASES OF THE AURICLE

MALFORMATIONS. — In *congenital* malformation the auricle may be represented merely by a fold of skin or a row of cartilaginous tubercles, or the auricle may appear turned forward with the helix fused to the tragus forming a longitudinal ridge. Accompanying these deformities may be found auricular appendages or congenital fistulae. With the more marked forms of mal-development may be associated complete atresia of the external meatus. This is not surprising, seeing that the external meatus, tympanic cavity, and the Eustachian tube are developed from the cleft between the first and second branchial arches, and the auricle from the tissues at the posterior margin of the cleft.

Acquired malformations may result from injury or disease. The commonest causes are othaematoma, perichondritis and frost bite.

Treatment.—If the malformation is slight, a plastic operation may be of some benefit. Accessory auricles are easily excised. When the deformity is great it may be concealed by an artificial ear, although in order to do so it may first be necessary to remove part of the existing deformed auricle, but a ridge should always be left as a *point d'appui*. These artificial ears can be obtained from Brooks of Halifax.

OTHAEMATOMA (*Haematoma Auris*).—This is an effusion of blood between the cartilage and the perichondrium of the auricle. It is commonly met with as the result of a blow, in footballers, and pugilists. It may also occur (apparently spontaneously, though probably arising from *slight* injury) in the aged or insane, degeneration of the cartilage and vessels being the predisposing factor.

After the injury, a bluish-red irregular and rounded swelling appears, usually occupying the upper half of the anterior surface of the auricle. It is doughy to the touch, and is opaque to transmitted light. Pain and tenderness are generally moderate.

Treatment is chiefly expectant. If the haematoma is large and the auricle hot and tender, applications of cold compresses of evaporating lead lotion are soothing and beneficial. Hot fomentations should be avoided in the earlier stages, as tending to increase the effusion. Usually the swelling subsides without suppuration.

In some cases resolution is not complete, the auricle remaining thickened and perhaps more or less deformed. After three or four weeks, if much thickening remains, gentle massage for five minutes twice daily may hasten its disappearance.

When the pain continues or the swelling increases in spite of treatment, after carefully cleansing the auricle and surrounding parts, the haematoma should be incised, the blood clot removed, and a small gauze drain inserted. A pad of sterilized gauze should then be placed behind and in front of the auricle, and gentle pressure applied by means of a bandage round the head.

If suppuration has taken place, a free incision must be made into the haematoma, its purulent contents together with any granulations or necrosed pieces of cartilage curetted away, and the cavity swabbed out with a solution of 1 in 500 of biniodide of mercury in rectified spirit, and then dried and packed with sterilized gauze. The dressings and the gauze packing should be changed daily at first if there is much discharge, but less frequently as the latter diminishes.

Prognosis.—The greater the destruction of the cartilage, the greater the deformity of the auricle. A simple haematoma rarely suppurates; if suppuration takes place, healing will be delayed until all the necrosed cartilage has been removed.

Diagnosis.—It may have to be diagnosed from perichondritis, an angeioma, a cyst, or possibly from a thickened auricle the result of chronic eczema. The history of the sudden onset after the injury should, in itself, be sufficient to make the diagnosis certain.

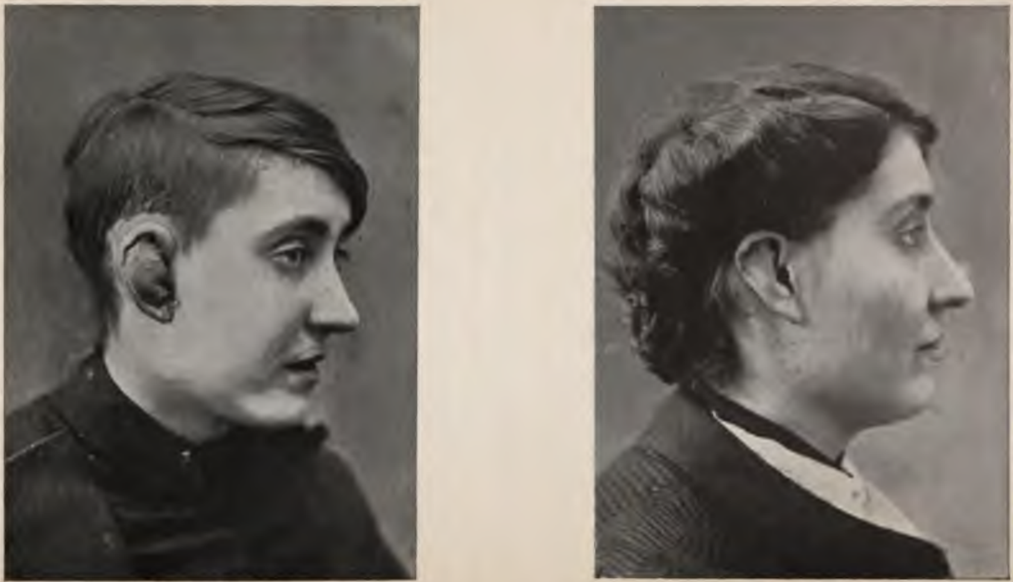
PERICHONDRITIS OF THE AURICLE.—It varies in the rapidity of its onset. In some cases its origin is apparently idiopathic; in other cases it is the result of infection following furunculosis, or an operation in the external meatus as in the cutting through of the cartilage for making the post-meatal flaps in the complete mastoid operation. It may also be due to syphilis, or occur as an after-result of frost bite.

The intensity of the symptoms varies with the cause. The idiopathic and syphilitic varieties are generally much less acute in their onset and course than in the form due to septic infection, and they show less tendency to the effusion of fluid or to subsequent suppuration.

Symptoms.—The inflammation usually begins with swelling at the entrance of the auditory canal which may in the first instance be mistaken for a furuncle. There is a feeling of heat or throbbing in the auricle. The swelling spreads to the inner surface of the concha and gradually involves the whole auricle except the lobule. The ear projects somewhat from the head, owing to oedema of the surrounding tissues, and is usually tender to the touch and on passive movement. The pain is often intense, and for the first few days there may be pyrexia. In the early stage the exudation between the cartilage and the perichondrium is serous or of a synovial character, and the perichondritis may then be distinguished from othaematoma by being translucent to transmitted light and by the uniform contour of its swelling. In slight cases the inflammation may subside and the auricle again become normal. In severe cases suppuration may occur ending in great deformity.

Treatment.—1. If the origin is apparently idiopathic and the inflammation not intense, pressure should be applied by placing a pad of gauze soaked in evaporating lead lotion in front and behind the auricle, and then applying a bandage.

2. If resolution does not begin to take place within a few days, or if pyrexia and pain continue, a free incision should be made over the swelling in front and behind the concha and the serous contents pressed out. Pressure is then applied between pads of sterilized



1. During acute stage.

2. Resulting deformity of auricle after recovery.

PERICHONDRITIS OF AURICLE.

[*Plate II.*

gauze. A recurrence of fluid may require further incision.

3. If the origin of perichondritis is due to virulent infection, suppuration may occur with extensive destruction of cartilage. For this reason it is better to incise early rather than too late. If suppuration has taken place, the treatment is the same as in the case of a suppurating haematoma. Owing to the destruction of the cartilage the deformity may be great, the auricle perhaps completely shrivelling into a small crumpled-up roll.

4. If the condition is the result of an operation on the external meatus, in addition to other treatment the latter should be carefully cleansed by the instillation of drops of liquor-hydrogen peroxide, being afterwards syringed out with 1 in 1,000 solution of biniodide of mercury, then dried and gently packed with gauze soaked in a solution of one part of carbolic acid in ten of glycerine.

5. If due to syphilis, it is of a gummatous nature. Incision should be avoided and anti-syphilitic treatment vigorously adopted.

ECZEMA.—The symptoms and treatment of eczema of the auricle are the same as those of eczema occurring in other parts of the body. The treatment described in detail for eczema of the external auditory meatus can also be applied to the auricle (page 40). If there is much thickening, this condition may have to be distinguished from thickening of the auricle, the result of perichondritis or haematoma.

HERPES.—Herpes of the auricle may also involve the external meatus. It is sufficient to protect the ear by dusting it with boracic powder and applying a pad of cotton wool.

SYPHILIS.—Syphilis of the auricle is rare. Gummata, or other tertiary lesions are the most common, secondaries are rare, and primary infection exceedingly so.

Their course, symptoms, and treatment are the same as that of syphilis in other parts of the body.

Gummata, from thickening and ulceration of the auricle, may have to be diagnosed from perichondritis or lupus.

LUPUS.—This is not of infrequent occurrence when other parts of the face are similarly affected. Its appearance and treatment do not differ from that of lupus elsewhere. It may possibly spread to the entrance of the auditory meatus and, from cicatricial contraction, produce stenosis or even atresia of the auditory canal. (For treatment, *see* page 32).

NEW GROWTHS.—They may be *benign* or *malignant*. Of benign growths the most common is a fibroma which is usually situated on the lobule, often the result of wearing ear-rings. Rarer conditions met with are angiomata, chondromata, lipomata, sebaceous cysts, dermoid cysts, cysts the result of haematoma, and cirsoid aneurism of the posterior auricular artery.

Fibromata, if small, require no treatment, but if large may, for cosmetic reasons, be excised.

Angiomata, as a rule, occupy the upper two-thirds of the auricle, and may extend into the external meatus.

Operative treatment should not be undertaken unless absolutely necessary. If the angioma is very small, repeated punctiform cauterization may gradually bring about a cure; after the use of the cautery there is always a risk of secondary haemorrhage. If the angioma is large, the vessels leading to the growth are first ligatured and the growth is then excised as completely as possible.

Sebaceous cysts are usually situated in the upper part of the auricle; their contents should be evacuated by a free incision, the lining membrane of the cyst removed, and the cavity packed with gauze. **Dermoid cysts** are usually situated just above and in front or behind the auricle; operation should not be advised, unless for some special reason, as removal is often difficult owing to their deep connexions. If the cyst wall is not completely excised, a fistula often results which may be more disagreeable than the original small tumour.

The *malignant growths* consist of **epitheliomata** of a nodular or ulcerating form, **rodent ulcer** and **sarcomata.**

They are described fully in all books of general surgery.

CHAPTER II

DISEASES OF THE EXTERNAL EAR

ANATOMY.—*In the adult* the external auditory meatus is a little more than one inch in length, measuring from the concha. It consists of a fibro-cartilaginous portion (outer one-third) and an osseous portion (inner two-thirds). The fibro-cartilage is a finger-like continuation of the auricular cartilage; it is incomplete in its upper and posterior part where fibrous tissue takes its place (*pars fibrosa*). In this cartilaginous portion are two transverse fissures known as the *fissures of Santorini*. These exist between the three centres from which the cartilage is developed. They permit of straightening of the external meatus during examination of the auditory canal and tympanic membrane; also an abscess of the parotid gland may break through them into the auditory canal. The cartilaginous portion is attached to the rim of the tympanic bone, whilst the fibrous portion is continuous with the lining membrane of the temporal bone. The external meatus is not a straight canal. As it extends inwards it forms a slight curve with its convexity upwards, the summit of which is situated at the junction of the cartilaginous and bony portions. In a horizontal section it points at first slightly backwards, and then forwards. Thus to straighten the external meatus and bring into view its deeper parts, the auricle must be pulled upwards and backwards. The lumen of the auditory canal varies in size : it widens in the cartilaginous portion, becoming narrower where it joins the osseous portion ; it slightly enlarges again, then narrows considerably, forming the *isthmus* and

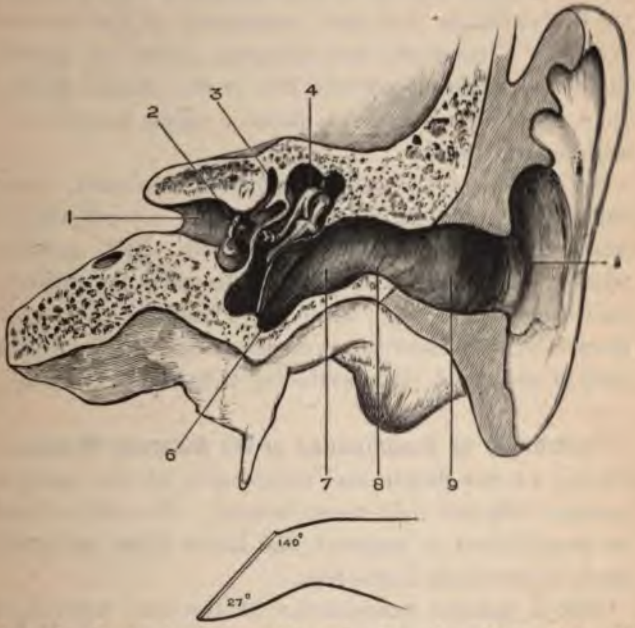


FIG. 1.—Vertical section through Ear—to show External Auditory Canal, Tympanic Cavity, and Internal Ear. (Drawn from a preparation in author's collection.)

1. Internal auditory meatus.
2. Labyrinth.
3. Semicircular canal.
4. Incus and malleus.
5. Concha.
6. Sinus of external meatus.
7. Bony meatus.
8. Narrowing of meatus at junction of cartilaginous and bony portions.
9. Cartilaginous meatus.

finally widens out just before the insertion of the tympanic membrane into the tympanic ring, forming the *sinus of the external auditory meatus.* (Fig. 1.)

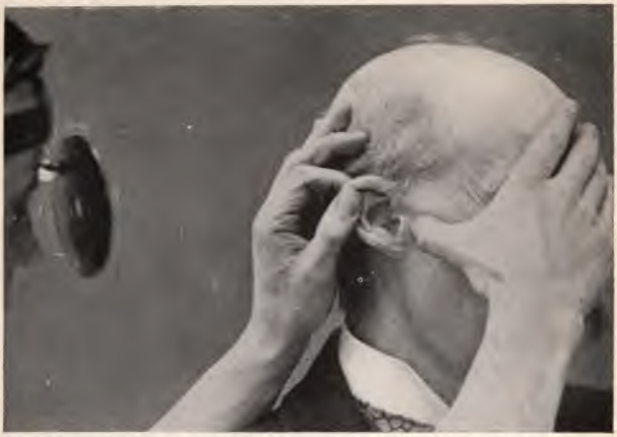
The external meatus is lined with skin closely united to the cartilage and the periosteum of the osseous portion. Ceruminous and sebaceous glands are present in the cartilaginous portion, but in the osseous portion they only extend a short distance along its posterior and superior wall.

In the infant the osseous portion is absent, being represented only by the tympanic ring, a small ring of bone incomplete in its upper part. The auditory meatus is formed by a fibrous canal to which the auricular cartilage is attached; after birth there is a gradual growth of bone from the tympanic ring into the fibrous wall of the canal, thus producing the osseous portion.

Technique of Examination of the External Meatus.—Owing to the depth and narrowness of the external meatus reflected light must be used. For this, a hand or head mirror is required, the latter being preferable as it leaves both hands free.

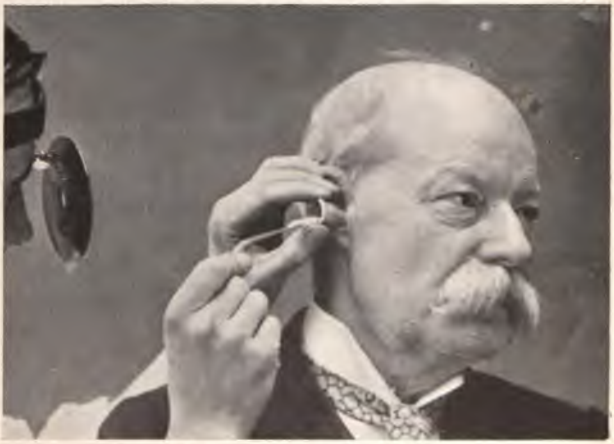
For a general examination of the ear, nose, post-nasal space and larynx the ordinary laryngological mirror, with a focus of 8 inches, is the most suitable, but a mirror of 4 to 5 inches focus gives a better view of the tympanic membrane. (Plate I, page 1.)

The *source of light* is usually artificial. By always using the same kind of light (electric for instance) a more accurate opinion of the various pathological conditions can be formed than by employing at one time electric light and at another an oil lamp or incan-



EXAMINATION OF EAR (WITHOUT USING SPECULUM).

The left hand pulls the auricle upwards and backwards; the right hand draws the tragus forwards.



DRY METHOD OF CLEANSING EAR.

[*Plate III.*

descent mantle. One of the most suitable lamps is that suggested by Dr. Greville Macdonald, which is furnished with a 32 c.p. burner frosted, or with a Nernst light.

Aural Specula.—Those devised by Gruber are very good and are to be obtained from every instrument maker. They are elliptical in shape in order to fit the auditory canal and vary in size. It is useful to have in addition a medium and small sized speculum with a round instead of an elliptical extremity.

Position of the Patient.—The patient should sit upright in a chair with the head turned sideways, with the ear to be examined towards the surgeon. The lamp should be a little behind and to the left of the patient. To obtain a good view of the external meatus (and the tympanic membrane) it is necessary to overcome the anatomical difficulties. In a child in order to convert the external meatus into a straight canal the auricle has to be pulled backwards ; in an adult backwards and upwards. In a young child, owing to the shortness of the meatus, a good view of its whole length can often be obtained by pulling forward the tragus with the finger of one hand, and the auricle backwards with the other. In an infant under four weeks of age the external meatus is very narrow, almost slit-like, and a deep view, especially of the drum, is difficult. In old people there is a tendency for the cartilage to prolapse forward, and narrow the entrance of the meatus.

The speculum should be gently inserted into the external meatus by the thumb and finger of one hand whilst the pinna is pulled backwards by the other.

When the right hand has to be free for manipulative work, the best method is to insert the speculum by means of the thumb and index finger of the left hand whilst the pinna is held between and pulled back by its second and third finger. On the right side the left hand should be behind the patient's ear: on the left in front and above it. (Plate IV.)

Points to Notice.—1. Always use the largest speculum which will comfortably enter the meatus.

2. Be gentle. Very often the meatus is exquisitely sensitive, as in furunculosis.

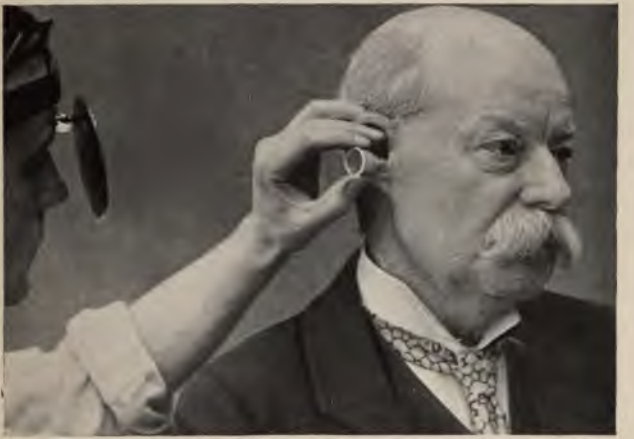
3. The speculum should only be introduced as far as the adaptable cartilaginous portion permits, about half an inch in an adult, and not forced into the bony portion.

4. If there is any difficulty in inserting Gruber's speculum the one with the round extremity should be substituted, and twisted round whilst being inserted.

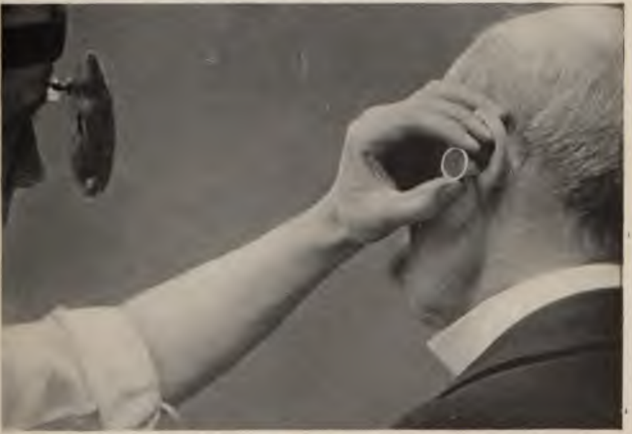
5. A view of the external meatus is sometimes prevented by tufts of hair filling up the meatus. To overcome this difficulty a smaller sized speculum should be used in order to push it further than usual into the meatus whilst the tufts of hair can be plastered down to the surface of the external meatus by smearing its surface with some simple ointment. Sometimes it may even be necessary to remove some of the hairs.

WOUNDS OF THE AUDITORY CANAL.—They may be caused by direct or indirect violence.

Direct injuries are seldom of much severity and are occasioned by the insertion of some foreign body into



Right side.



Left side.

EXAMINATION OF EAR.

[Plate IV.

the ear, such as slate pencils by children, and hair pins or matches by adults. The indirect injuries are of a more serious nature, being the result of fracture of adjacent bones.

A direct blow on the chin acting through the condyle of the lower jaw may fracture the glenoid fossa, or a fracture through the middle fossa of the skull may involve the upper bony wall of the meatus; the latter is generally accompanied by rupture of the tympanic membrane.

Symptoms.—Haemorrhage is the chief symptom, but in fractures through the middle fossa there may also be a flow of cerebrospinal fluid.

In fracture of the glenoid fossa with displacement upwards of the condyle, there will be crepitus and pain on movement of the lower jaw and the dislocated condyle will be recognized in an abnormal position, compressing the auditory meatus.

Treatment.—The greatest care must be taken to guard against sepsis. All blood clots should be removed by syringing with a saturated solution of boracic acid. After careful inspection of the meatus and tympanic membrane, the former should be dried and lightly packed with sterilized gauze, and the whole ear covered with a gauze dressing and bandage. In fractures it is more than ever important to maintain asepsis.

In fractures through the glenoid fossa the dislocated condyle must be reduced and the auditory canal restored as far as possible to its normal condition. The external meatus should be packed firmly with gauze for about a fortnight to prevent the occurrence of stenosis.

DISEASES OF THE CERUMINOUS GLANDS.—There may either be increased secretion resulting in an accumulation of wax, or diminished secretion causing dryness of the ear.

1. Diminished Secretion.—In this condition the auditory meatus is pale and dry, and it may be accompanied by desquamation of the epithelium, causing considerable irritation and itching of the ear. Dryness of the auditory meatus often occurs in cases of otosclerosis, or in the later stages of chronic middle ear catarrh.

Treatment.—The irritation or itching is best relieved by occasionally painting the surface of the auditory canal with an ointment consisting of one part of nitrate of mercury ointment and eight parts of vaseline.

2. Increased Secretion.—This is only of practical interest in that it may give rise to obstruction of the auditory canal. At first the ceruminous secretion is soft and of a brownish colour; in long standing cases the obstructing plug may consist of a hard mass of cerumen, epithelial débris and hair, of a black, grey or yellowish-white colour.

Symptoms.—These vary very much in their degree. If the obstruction is incomplete the patient may experience no discomfort of any kind. If complete obstruction has resulted from the very gradual enlargement of the plug of cerumen, deafness will be the chief complaint. In many cases, owing to a rapid swelling of the ceruminous mass, generally due to water getting into the ear, the onset of the deafness is sudden, and is frequently accompanied by a feeling of fullness in the head, tinnitus and giddiness. Cases have been recorded in which the removal of impacted cerumen has brought about the cessation of epileptic seizures.

On examination, the external meatus will be found to be obstructed by a black, brown or greyish mass, which may be soft or hard on touching it with a probe. The plug may be so large as to almost protrude from the meatus, or on the other hand may merely form a thin layer lying against the tympanic membrane; in the latter case it can easily be overlooked.

Diagnosis.—Inspection of the meatus usually makes the diagnosis obvious; a plug of cerumen, however, may be confused with dried-up blood crusts, a cholesteatomatous mass the result of chronic otorrhoea, or a pledget of wool or other foreign body.

Prognosis.—If the deafness is solely due to impacted cerumen the prognosis is, of course, excellent, but the patient must be reminded that the accumulation will almost certainly recur. It is unwise on the mere discovery of cerumen blocking the external meatus to promise the patient certain restoration of the hearing after its removal. In some cases removal of the cerumen does not benefit the hearing to any great extent owing to the existence of middle or internal ear disease. Cases indeed are known where the removal of wax has caused increase of deafness owing to the fact that the plug of cerumen had been covering an existing perforation, and acting as an artificial drum.

Treatment.—If the plug is soft and of recent origin it may be at once removed by syringing. If, however, it is very hard and firmly impacted, its removal should not be immediately attempted; it is wiser to get the patient to instil into the ears, night and morning, some of the following drops :—

Sodium Bicarbonate	½ drachm
Glycerine	1 ,,
Water	to the ounce

This may have to be repeated for two or three days before the cerumen is softened. If it is absolutely necessary to remove the wax at the first sitting, a few drops of liquor hydrogen peroxide may be instilled into and left in the ear for at least fifteen minutes. The plug may then become sufficiently loosened to permit of its removal by syringing. Sometimes considerable patience is required in this simple operation ; many syringefuls may have to be employed before the cerumen comes away ; when it does, it is usually in the form of a large plug, and the patient at once feels a sense of relief.

As soon as a plug of cerumen has been removed, the meatus should be examined to see if any more wax exists. Syringing must not be more forcible than is actually required to remove the cerumen ; forcible syringing is not only painful, but may set up an acute inflammation of the external meatus, especially if the obstructing plug be closely adherent to the walls of the auditory canal, as in these cases portions of the lining epithelium may be removed with the plug, leaving raw patches easily infected by septic material. After the ear has been syringed it should be thoroughly dried. The meatus may appear red or raw in patches and the membrane congested. It is usually sufficient to protect the ear by a pledget of wool placed in the auditory canal, but if there is much excoriation of the meatus it is advisable to instil into the ear for a few days drops containing 1 drachm of nitrate of mercury ointment to 1 ounce of olive oil.

Sometimes after removal of the cerumen, although the patient has experienced great relief, a sensation of stuffiness in the ears and tinnitus may still persist; in such cases the tympanic membrane is usually found to be markedly retracted from the continuous pressure of the cerumen against it: gentle politzerization, provided the middle ear is otherwise normal, will relieve these symptoms. If, as a result of syringing, the membrane is found to be much congested, it is wiser to postpone inflation of the ears for two or three days.

INFLAMMATION OF THE EXTERNAL MEATUS.—This may be either circumscribed or diffuse.

1. **Furunculosis** (*Otitis Externa Circumscripta*) occurs in adults rather than in children, and is due to staphylococcic infection of a hair follicle usually the result of an abrasion of the skin from scratching the ear, or from the insertion of an instrument for the removal of cerumen or a foreign body. It may also occur in the course of middle ear suppuration, in diabetics, or after extensive use of bromides.

Subjective symptoms.—The onset is sudden, and is accompanied by pain which may radiate over the head and jaws; the pain is worse at night, often of an acute lancinating or throbbing character, and is not proportionate to the size of the furuncle. There is no deafness unless the external meatus is completely obstructed by the swelling. Slight pyrexia is not uncommon, and the patient is often ill from pain and want of sleep.

Objective signs.—The entrance to the auditory canal may be so swollen as to prevent inspection of its deeper parts ; the insertion of a speculum may be impossible owing to the intensity of the pain produced. One or more furuncles may be present ; if solitary it usually occupies the floor of the canal just within the meatus. In the early stage there may merely be one or more slight swellings, exquisitely tender on probing. The furuncles are usually limited to the cartilaginous portion but may extend a short way into the bony portion along its upper posterior wall. Within two or three days after the onset, points of pus may appear on the summit of the swellings ; the furuncle usually bursts about the third or fourth day, but may not do so until two or three days later. After bursting the pain is at once relieved, and as a rule the swelling subsides rapidly. Recurring crops of furuncles are not uncommon owing to auto-infection. The auricle is sometimes swollen and may project slightly from the head ; oedema of the soft tissues behind the ear may obliterate the fold between the auricle and tip of the mastoid process, and in some cases extend up towards the parietal region. The preauricular glands are enlarged and tender. In addition there may be extreme pain on movement of the jaw, especially on mastication, on traction of the auricle, and on pressure behind it low down in front of the mastoid process.

Treatment.—The first object is to relieve the pain. In the early stage frequent instillation of a few drops of the following is often of great service :—

Carbolic acid	6 grains
Morphia hydrochloride.	3 grains
Glycerine	1 drachm

The drops should be instilled as warm as can be borne. Instead of these drops may be used Aural "Ovoids" containing cocaine, $\frac{1}{10}$th grain; extract of opium, $\frac{1}{5}$th grain; or morphia hydrochloride, $\frac{1}{15}$th grain. They are inserted into the meatus, where they gradually dissolve.

In addition, warm dry applications to the head are very soothing; the ordinary *hot* fomentations should be avoided, as tending to favour the production of furuncles. Sometimes, however, the application of heat increases the pain; in suchs case cold compresses of boracic lint should be tried. In other cases much benefit is derived from the insertion of a pledget of wool soaked in a solution consisting of:—

Subacetate of lead	10 grains
Acetate of morphia	10 grains
Distilled water	1 ounce

These pledgets should be changed, if possible, every hour.

An attempt may be made to abort an attack of furunculosis in its earliest stages by frequent instillations of drops consisting of a 1 in 2,000 solution of biniodide of mercury in absolute alcohol.

If, in spite of these measures, the pain increases, or if pus is obviously present, it is necessary to *incise the furuncles.* This should be done under gas anaesthesia. To incise a furuncle even under a local anaesthetic is exceedingly painful, and may produce considerable shock.

For the incision a small knife shaped like a bistoury is used. The furuncles should be freely opened and their contents scooped out with a tiny curette. The meatus should then be syringed out and dried, and, whilst the patient is still under the influence of the anaesthetic, packed tightly with gauze which has been moistened with an oil containing 1 drachm of nitrate of mercury ointment to the ounce. The gauze prevents the furuncles from coming in contact with one another and by exercising pressure squeezes out their contents, and at the same time, dilates the canal. If possible the gauze should be left in 24 hours, but if the pressure causes much pain it may have to be removed before this. After the incision there is usually immediate relief. The gauze dressing should be changed as often as may be necessary. The oil containing mercury acts as a strong antiseptic and tends to prevent the recurrence of furuncles, and the patient should be advised to occasionally smear the auditory canal with a little of this oil for some weeks, even although the ear seems normal. Sometimes as a result of furunculosis, patches of granulations form within the meatus; these should be removed under cocaine by means of the curette, and the surface touched with silver nitrate stick or trichloracetic acid. If the patient refuses to permit of incision of the furuncles, an attempt should be made to relieve the pain by applying leeches to the front of the ear if the furuncles are on the anterior wall, or behind the ear if on the posterior wall, and by frequent syringing with very hot lotions. Constitutional treatment consists in the giving of a tonic such as Easton's syrup or, when there is also furunculosis of other parts of the body, injections of anti-staphylococcic vaccine in accordance with the principles laid down by Sir A. E. Wright.

Prognosis.—Relapses may be frequent.

Diagnosis.—Furunculosis has to be diagnosed :

(1) From inflammation of the mastoid process (see page 197).

(2) From an exostosis, especially if the skin over it be inflamed. The diagnosis can be made by means of a probe ; an exostosis is usually not tender and is of bony hardness to the touch.

(3) From a parotid abscess ; in rare instances a parotid abscess may burst into the external meatus through one of the fissures of Santorini. The diagnosis is made from the history of a swelling over the parotid region and the appearance of pus in the external meatus on pressure over the gland.

(4) From polypi ; inspection and the use of a probe are usually sufficient to make the diagnosis clear. Difficulty in diagnosis only arises when a polypus, due to disease in the attic, projects through a fistula in the upper wall of the external meatus without there being any perforation of the membrane ; this is of very rare occurrence.

(5) From granulations of the external meatus from whatever cause, by the length of time they have existed, by the absence of acute pain, and by the use of the probe.

(6) From perichondritis of the auricle (see page 4).

2. **Diffuse inflammation of the external meatus** (*Otitis Externa Diffusa*).—This condition is due to the same causes as furunculosis, which it may give rise to or accompany. In addition it may occur as the result of some skin eruption such as eczema o

erysipelas. It usually involves the whole surface of the meatus, but more especially the osseous portion and the outer surface of the tympanic membrane.

Subjective symptoms.—Unlike furunculosis, the pain is not so acute, but is more of the character of a deep-seated aching accompanied by a feeling of heat and irritation in the ear. As in furunculosis, there is usually tenderness on mastication and traction of the auricle.

Objective signs.—The meatus may be so swollen as to prevent inspection of its deeper parts; the swelling is uniform, and may also involve the auricle.

In the earliest stages the walls of the auditory canal are in a state of marked congestion and tender to the touch, and it may be difficult to distinguish where they end and where the tympanic membrane begins. Very soon there follows desquamation of the epithelium with serous exudation, which gradually becomes purulent. At this stage if the meatus is cleansed, a large portion of the surface may be found denuded of its epithelium and of a raw appearance; in the later stages the whole surface of the meatus and tympanic membrane may be lined with granulations, and the secretion in some instances is profuse.

Under treatment resolution usually takes place, the secretion becoming less, the granulations disappearing, and finally the contour of the membrane and malleus can be made out. The congestion gradually diminishes until the auditory canal is again almost normal. For some time the epithelium may be shed in sheets or casts leaving a smooth raw surface. In other cases the inflammation may extend to the deeper parts involving the periosteum and perichondrium.

Treatment.—In the earlier stages treatment is the same as for furunculosis; scarification of the meatus is seldom of much benefit. Cold compresses of evaporating lead lotion or boracic lint, and the frequent instillation of drops of a 10 per cent. solution of carbolic acid and glycerine is the simplest and at the same time the most effective method of treatment. In the stage of purulent secretion the canal is cleansed by a solution of liquor hydrogen peroxide (vol. 10) which is left in the ear for at least 10 minutes; the ear is afterwards syringed out with a solution of 1 per cent. solution of lysol, or a solution of potassium permanganate. The meatus is then dried, and slightly plugged with gauze. If the secretion is profuse it may be necessary to cleanse and syringe the ear twice daily at first, but as soon as the secretion diminishes it should be repeated less frequently. In the later stages the effect of stronger astringents and antiseptics may be tried, such as drops of a 1 in 2,000 solution of biniodide of mercury, or 2 grains of salicylic acid in an ounce of rectified spirit. The meatus should be filled with the drops and after 10–15 minutes the excess of fluid should be mopped out and a small pledget of wool placed in the ear. In other cases a better result is obtained by thoroughly drying the auditory canal, painting its surface with 10 per cent. solution of silver nitrate and then puffing in boracic acid powder. When in spite of all treatment patches and granulations remain, they may be cauterized, under a local anaesthetic of cocaine, with silver nitrate stick, chromic or trichloracetic acid, or a 10 per cent. solution of salicylic acid and alcohol. As in furunculosis, when a cure has been obtained the patient should be directed to occasionally paint the surface of the meatus with an oily solution of nitrate of mercury. This, in addition to being an antiseptic, often relieves the intense irritation which may be met with in such cases, especially if occurring in the course of a chronic eczematous condition of the auditory canal.

Prognosis.—The majority of cases can be cured; some, however, run an obstinate course, often owing to the patient neglecting to carry out the treatment. If the case becomes chronic it may end in considerable stenosis of the external meatus from thickening of its walls or from cicatricial contraction following ulceration, or it may, though rarely, give rise to middle ear suppuration from perforation of the tympanic membrane.

Diagnosis.—It is necessary to make certain that there is no involvement of the middle ear. The secretion is sometimes so profuse that middle ear suppuration is suspected, especially if the surface of the membrane is completely covered by granulations. The diagnosis is based on the fact that in inflammation of the external meatus the hearing is good unless the meatus is completely obstructed, and on the absence of signs of a perforation in the membrane (see page 143).

FOREIGN BODIES.—Foreign bodies in the ear are met with most frequently in children, who insert them on purpose; in adults their occurrence is usually accidental, except when they have been put in for a specific purpose such as the centre of an onion to relieve earache, or a pledget of wool. They may consist of living insects, such as flies, fleas, earwigs, maggots or even cockroaches; or vegetable substances or seeds such as a pea, bean, or an ear of corn; or hard substances as a button, a fruit-stone, a piece of wood, shot, or a piece of slate pencil.

Symptoms.—An inert foreign body may remain for an indefinite period within the auditory canal without giving rise to any symptoms, but on the other hand the irritation may be sufficient to give rise to an attack of coughing, vomiting, or even an epileptiform seizure.

If the meatus is completely blocked, there will be deafness, occasionally accompanied by tinnitus or attacks of vertigo. The foreign body may set up acute inflammation of the external meatus accompanied by a purulent discharge which usually does not cease until it has been removed. Living insects by their scratching movements against the tympanic membrane may set up the most intense pain and tinnitus.

Foreign bodies in themselves rarely give rise to any serious complications; as a result, however, of injudicious attempts to remove them by means of instruments, especially without the assistance of artificial light and a speculum, the tympanic membrane may be injured with a subsequent middle ear suppuration or acute inflammation of the mastoid process; or even meningitis has been caused by direct injury of the inner wall of the tympanic cavity.

There are three methods employed for the removal of foreign bodies:—(1) Syringing; (2) Extraction by instruments through the external meatus; and (3) Removal by operation.

Treatment.—1. **Syringing.**—Provided that injudicious attempts have not been made to remove the foreign body by means of instruments, syringing, except when contra-indicated, should always be tried, and in the great majority of cases is successful. If the foreign body is a hard substance there is no urgency to attempt its removal, but if it is a pea or bean, or some vegetable seed, it must be remembered that moisture in the ear may cause it to swell, and in such cases delay may increase the difficulty of removal. Before syringing, a careful examination of the ear should be made to make certain that a foreign body really is present, and also to see if any chink exists between it (if one is present) and the meatus, in order to direct the stream of lotion towards this point. If the foreign body cannot be removed by careful and prolonged syringing, drops of rectified spirit should be instilled several times a day into the ear; this tends to diminish any swelling of the external meatus and to cause shrinking of the foreign body if it is a vegetable substance. After two or three days the ear should again be syringed. If the foreign body cannot yet be expelled it should gently be moved with a probe (using a speculum and reflected light), great care being taken not to push it further within the auditory canal, and a final attempt made to remove it by *prolonged* syringing. If this attempt fails, the foreign body must be extracted by instruments.

When the foreign body is a living insect, it should at once be killed by the instillation of a few drops of oil or rectified spirit, and after a few moments removed by gently syringing. If the insect is large, like a cockroach, it may be so firmly impacted within the meatus that it has to be removed by forceps. If the insect is very tiny and the sinus of the external meatus very large, it may be impossible to see it, even after a thorough inspection of the auditory canal, but its presence may be suspected from the agonising tinnitus and pain produced by its movements on the drum.

Syringing is contra-indicated.—(1) If the foreign body is of such a nature that it may be driven inwards; for example, a percussion cap, such as boys use for toy pistols, when it lies with its concavity directed outwards. (2) When there is much inflammation and swelling of the walls of the external meatus, the result of previous ill-advised attempts at extraction of the foreign body. In such cases, unless there are urgent symptoms of retention of pus behind the foreign body, it is better to wait until the inflammation subsides in order that the canal may become more patent and give a more favourable opportunity for its removal. If the purulent discharge is very profuse the ear should be cleansed with a warm solution of boracic acid or potassium permanganate; after being carefully dried, drops of rectified spirit should be instilled into the meatus.

Syringing must be stopped—(1) if the foreign body is deeply placed within the osseous portion and tends to get driven inwards instead of outwards, or (2) if the syringing produces violent giddiness, showing the possible presence of perforation of the tympanic membrane.

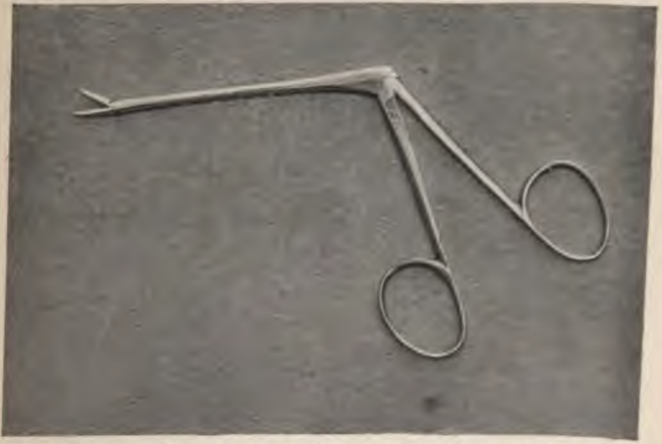
2. **Extraction by means of Instruments through the External Meatus.**—This is indicated (1) When repeated attempts at syringing have failed to remove the foreign body. (2) If a foreign body, owing to previous attempts by others to remove it by means of

instruments, has been pushed in beyond the isthmus and prolonged syringing fails to remove it. (3) If there are signs of acute inflammation of the middle ear, or of pus being pent-up behind the foreign body.

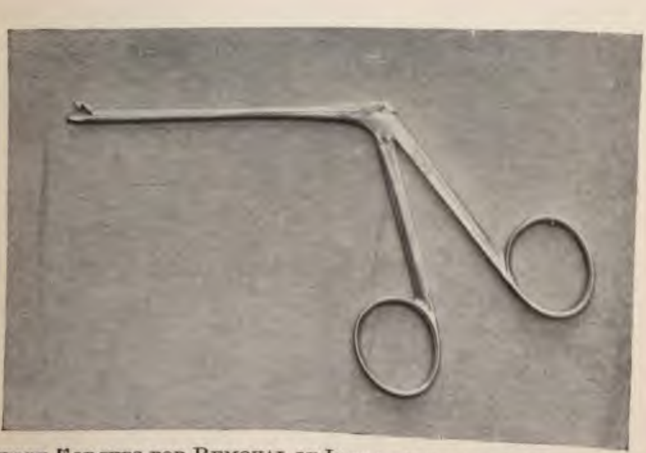
Many instruments have been devised for the purpose of extracting these foreign bodies. They consist of forceps, or of tiny hooks or scoops of varying size and shape. Sometimes it is possible to pass a loop of wire round the foreign body; at other times it can be seized by a pair of fine forceps. In a child a general anaesthetic should be administered; in adults, this is only necessary if it is expected that the extraction will be difficult. If no anaesthetic is given the head must be firmly supported by an assistant, to prevent movement. A clear view of the auditory canal must be obtained by means of reflected light. A speculum will be necessary if the foreign body lies deep in the auditory canal; the largest possible speculum should be used. The instrument used depends on the character and position of the foreign body.

Points to be observed are :—(1) Not to push the foreign body further in. (2) Not to injure the auditory meatus or tympanic membrane.

If the foreign body lies in the outer part of the canal, the instrument is best introduced above or behind it; when it lies beyond the isthmus, the instrument should be inserted along the anterior inferior border of the canal. A soft substance can sometimes be broken up and afterwards removed by forceps or syringing. After removal of the foreign body, whether by syringing or by instruments, the meatus should be carefully inspected. If the tympanic membrane and



Crocodile Forceps for Removal of Foreign Body.



Punch Forceps for Removal of Intra-tympanic Granulations.

[Plate V.

auditory canal have not been injured, it is sufficient to dry the meatus and puff in a little boracic powder. If there are abrasions of the canal, a small strip of gauze should be inserted and changed as frequently as may be necessary. If the tympanic membrane has been wounded, with a resulting middle ear suppuration, this must be treated by the ordinary methods (*see* page 145).

3. **Removal by Operation.**—(*a*) The indications for removal of a foreign body *by turning forward the auricle by means of a post-aural incision* are :—(1) When a prolonged attempt to remove a foreign body by instruments has failed. This becomes *imperative* if there are signs of retention of pus in the middle ear. (2) If the foreign body has been pushed into the tympanic cavity, and cannot otherwise be removed.

Technique of Operation. —The ear and surrounding parts must be carefully cleansed, and the head shaved for a short distance over and beyond the mastoid process. Under a general anaesthetic a curved incision is made *close behind the auricle* beginning at the upper level of the external auditory meatus, and extending downwards for one and a half inches. The incision goes down to the bone. By means of a periosteal elevator the auricle is reflected forward until the posterior upper margin of the bony canal is brought into view ; the fibrous portion of the canal is carefully separated from the bony portion. A transverse incision is now made through the fibrous portion of the fibro-cartilaginous meatus, and the cut edges of the incision are held aside by means of forceps. Usually, the foreign body can be seen lying in the canal, and can be easily removed.

If, however, it lies beyond the isthmus, it may be necessary to make a longitudinal incision through the posterior wall of the fibrous portion reaching almost to the tympanic membrane, and at the same time to remove part of the posterior wall of the bony canal. The antrum should not be exposed, and great care must be taken not to injure the tympanic membrane.

After removal of the foreign body, the wound cavity is carefully dried and the auricle pressed back into its normal position; the edges of the skin are then accurately sutured together.

All blood clot is removed from the auditory canal, which is now firmly packed with sterilized ribbon gauze to prevent subsequent stenosis. The packing keeps the edges of the incision in position. If, in the first instance, there was no suppuration, the packing need not be changed for at least a week. The auditory meatus should be kept packed for two or three weeks until healing has taken place. If granulations occur, they should be touched with a cauterizing agent, or, if exuberant, removed by a small curette.

(*b*) *The complete mastoid operation may be necessary* if the foreign body cannot be removed from an ear (1) in which there is a chronic middle ear suppuration and the retention of pus gives rise to symptoms of mastoid disease; or, (2) when there are symptoms of impending meningitis or facial paralysis.

STENOSIS OF EXTERNAL MEATUS may be either complete (atresia) or partial (stricture), congenital or acquired.

1. **Atresia**—(1) **Congenital.** This may occur in a normally developed auricle, but usually it is also deformed. The atresia is almost invariably bony, and may be so complete that no sign of the entrance into the external meatus exists, or there may be only a small indentation at the position of the meatus, or a small saccule of shallow depth. The point of occlusion is most frequently situated at the junction of the cartilaginous and bony portions of the auditory canal; cases also have been recorded where the atresia has been due, not to a bony, but to a membranous septum. Other deformities which may accompany congenital atresia of the external meatus are asymmetry of the face and palate due to the affected side being smaller, facial paralysis, absence of the mastoid process, deformity of the mouth, fistulae in the cheek, and obstruction of the posterior choanae of the nose.

Treatment.—If the atresia is merely membranous (an exceedingly rare condition), an attempt may be made to remove it by excision. *In cases of bony atresia operative interference is absolutely unjustifiable.* That this operation always results in failure is not to be wondered at, since atresia of the external meatus is always associated with mal-development of the middle ear.[1]

In these cases the labyrinth is rarely affected. The hearing power is slight, but is present to some extent. Hearing tests give practically the same results as those obtained in an advanced case of middle ear disease. Treatment should be directed to early and careful instruction in speaking and lip reading.

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[1] Paper by Author: *Journal of Laryngology*, March 1901.

(2) **Acquired.**—This is of rare occurrence, the result either of wounds, extensive ulceration, operations, over-use of cauterizing agents, or caries and necrosis of the external meatus. The occlusion of the external meatus may be due to either a membranous diaphragm or fibrous tissue.

Symptoms.—The condition is usually discovered accidentally, the patient seeking advice with regard to deafness.

Treatment.—The nature of the condition is determined by means of a probe. On inspection the walls of the meatus are seen to merge into a cul-de-sac. The usual position of the atresia is at the junction of the cartilaginous and bony portions of the meatus. If the atresia is due to a *membranous septum*, it should be excised as completely as possible by means of a small bistoury such as is used in incising furuncles. This operation may either be done under a local or general anaesthetic. Before operation, the auditory canal and the surrounding parts should be carefully cleansed and dried. After the membrane has been removed, the auditory canal must be firmly packed with sterilized gauze, which should be left in situ for four or five days. On its removal a silver, vulcanite, or celluloid cannula, adapted to fit the auditory canal, is inserted. It should only be removed in order to cleanse it, and must be worn until healing is complete. If stenosis tends to recur on removal of the cannula, it may be necessary to retain it for months or years. If the atresia is due to *fibrous tissue*, it is usually so dense that operative treatment through the external meatus is impracticable. Under a general anaesthetic a curved incision is made close behind the auricle, which is reflected forward. A transverse incision is made through the posterior wall of the cartilaginous meatus, close to the bony portion, and the fibrous stricture excised. The auricle is then restored to its normal position and the edges of the skin sutured together. After carefully drying the auditory canal small skin grafts are applied to its wound surface, and kept in position by gauze impregnated with aristol powder. A dressing is then applied and not removed for eight days, unless there are special indications for so doing. If grafting is not done, or has been unsuccessful, the auditory canal must be kept packed with gauze until the wound has completely healed. Granulations should be touched, in the ordinary way, with chromic or trichloracetic acid. If the meatus tends to reclose from cicatricial contraction, a cannula must be retained in the ear, as in the case of atresia due to a membranous band. As these operations are often unsuccessful, they should not be undertaken except in the hope of improving the hearing power in cases where deafness is extreme on both sides. If the patient cannot hear fairly well through a speaking tube, or if there is loss of bone conduction and inability to hear high tuning-forks, an operation should not be performed, as the result will be negative.

2. **Stricture of the External Meatus.**—In addition to the causes given for atresia, a stricture may also be due to the presence of exostoses or hyperostoses, or be the result of diffuse inflammation of the external meatus. Congenital stricture is exceedingly rare.

Symptoms.—The stricture is either discovered accidentally from deafness due to obstruction of the narrowed meatus by a plug of cerumen or epithelial débris, or from the retention of pus in a middle ear suppuration, the result of insufficient drainage, giving rise to earache, headache, or symptoms of mastoid disease.

Treatment.—(1) A plug of cerumen or epithelial débris should be removed. Sometimes this can only be done by inserting a fine tympanic syringe through the narrowed portion of the canal, and washing out the plug, piecemeal. If there is no middle ear disease and no perforation of the tympanic membrane, it is sufficient to instruct the patient to occasionally instil into the ear, at bedtime, a few drops of the glycerine and sodium bicarbonate lotion, and to syringe the ear next morning with boracic lotion. At the same time he should be warned, if these measures are not successful, to return to his medical attendant. If obstruction of the meatus from plugs of cerumen or epithelial débris recurs frequently, an attempt should be made to bring about a gradual dilatation of the canal by plugging it with sterilized gauze or by the introduction of compressed sterilized sponge tents, which should be left in the meatus for twenty-four hours, unless they produce pain, when they should be at once removed.

(*N.B. This method only applies to cases in which inspection has shown that there is neither perforation of the tympanic membrane, nor middle ear suppuration.*)

Treatment of stenosis due to thickening of the soft tissues from chronic inflammation usually gives very unsatisfactory results. The stricture, especially if it is of a membranous character, should be excised under a general anaesthetic. If the stricture is progressive, a cannula may have to be worn in order to prevent complete atresia.

(2) If the stricture of the external meatus is discovered accidentally in the course of chronic middle ear suppuration, two courses are open :—

(*a*) If there are no symptoms of retention of pus, the auditory canal should be carefully cleansed and dried twice or three times a day, and a wick of gauze inserted to act as a drain. After cessation of the purulent discharge and healing of the perforation of the tympanic membrane, the stricture of the auditory canal should then be treated as has been already described.

(*b*) The complete mastoid operation is indicated in order to at once remove the present or future danger of insufficient drainage. (i) If there are symptoms of retention of pus; (ii) if the stricture is fibrous in character, and the passage of the meatus very narrow so that dilatation seems impossible and suppuration continues; (iii) if there are granulations in the tympanic cavity, or any signs of bone disease.

EXOSTOSES AND HYPEROSTOSES OF THE EXTERNAL MEATUS.—When the growth is circumscribed, it is termed an *exostosis;* when it is diffuse and fades off into the surrounding tissue, it is known as *hyperostosis.* These growths are composed of compact or cancellous bone. Their origin is uncertain. If the exostoses are bilateral and especially if they occur close to the membrane at the anterior or posterior margin of Shrapnell's membrane (i.e. the margins of the tympanic ring), they may be due to some abnormality of development. They frequently occur in those suffering from gout, chronic rheumatism, or chronic middle ear catarrh. Hyperostoses, rather than exostoses, are found as a general thickening of the upper posterior wall of the auditory canal, in cases of chronic otorrhoea, probably the result of irritation from the constant discharge of pus. Exostoses are said to be of frequent occurrence in seafaring men. They may be single or multiple. If single, they are usually situated at the outer part of the bony auditory canal on its posterior wall, and may be pedunculated; when multiple they may grow from any part of the meatal wall. Their growth, as a rule, is very slow.

Course and Symptoms.—They may be discovered accidentally in the course of examination of an ear for deafness, the result of cerumen obstructing the narrow meatus, or in a chronic middle ear affection, suppurative or non-suppurative. The exostoses themselves, when they are sufficiently large, may completely block the meatus and thus produce deafness, or by actual pressure against one another give rise to a painful inflammation or even ulceration with purulent discharge. On examination the meatus is found to be partially or completely blocked. The exostoses are of a yellowish white appearance, and stand out prominently from the surrounding bony wall; they are found to be hard when touched with a probe, and, unless inflamed, are not tender.

Treatment.—(1) If there is no middle ear suppuration and only slight stenosis of the meatus, no treatment is necessary. The auditory canal should be inspected from time to time to prevent plugs of cerumen obstructing the narrow meatus.

(2) If the exostoses are large, and there is pain from their pressing one against the other, immediate treatment should be directed towards relieving the pain and inflammation. Drops of carbolic acid in glycerine (1 in 10) should be instilled into the ear two or three times during the day. After the acute inflammation has subsided, an attempt may be made to reduce the swelling by prescribing drops consisting of 10 grains of boric acid or menthol in 1 oz. of rectified spirit. If a sufficient opening can be obtained, so that the hearing again becomes normal, no further measures are urgently indicated. The patient, however, should be warned to protect the ear against the entry of water which may again cause inflammation of the lining membrane; he should also be informed of the importance of at once obtaining medical advice if at any future period he has earache, which may be the result of further inflammation of the external or middle ear.

(3) *Operation is justifiable and indicated*—(*a*) If there is middle ear suppuration and signs of retention of pus. (*b*) When the pressure of the exostoses produces pain which cannot be relieved. (*c*) If the exostoses nearly block up the external meatus of both ears, and there is every prospect of each side becoming completely blocked in the near future, an operation should be advised on the worst side. (*d*) If the meatus is nearly blocked by exostoses and the patient intends going to a country where he cannot possibly be within reach of a competent medical man for a long period.

Operation is contra-indicated if there are no signs of middle ear suppuration, and careful examination indicates that the deafness is due to a chronic middle ear catarrh or internal ear disease. This should be clearly explained to the patient.

Methods of Operation.—In former days an opening was made through the auditory canal by means of a dental burr. This is now given up by the majority of surgeons as being not only un-surgical but dangerous, owing to the difficulty of controlling the burr.

The operation can be performed :—(1) *Through the external meatus.* This is only permissible where the exostosis on probing is found to be pedunculated, and is situated on the outer part of the bony meatus. The meatus is carefully cleansed and the largest possible speculum is inserted into its orifice. The surgeon works by reflected light. A small gouge is used and inserted into the meatus so that its point presses between the pedicule of the exostosis and the wall of the bony meatus; the head of the gouge is then sharply tapped with the mallet, so that the exostosis is cut through, care being taken that the gouge is not driven in too deeply on to the tympanic membrane. The exostosis is now removed, the meatus being afterwards dusted over with boracic powder and lightly packed with gauze. The dressing is changed as often as is necessary until healing takes place. (2) *By reflecting forward the auricle.* This is indicated if the exostoses are multiple, have a broad base, and are deeply situated. The auricle is reflected forward in the same manner as for removal of foreign bodies (*see* p. 29). When the bony portion of the external meatus comes into view, the membranous part is carefully separated from it, exposing the growth. (*a*) If the exostosis is on the posterior, postero-superior, or inferior wall, it is removed by chiselling with a gouge. (*b*) If the exostosis is deeply situated, it is more easily removed by first chiselling away part of the posterior wall of the external meatus. The antrum must not be exposed, and care must be taken not to cut too deeply, in order to avoid wounding the tympanic membrane. If the exostosis springs from the anterior wall, it is necessary to make a longitudinal incision through the posterior membranous portion of the auditory canal. The cut surfaces are held apart by means of forceps, bringing into view the anterior wall of the external meatus. The exostosis can now be removed by means of a gouge. After removal, the auricle is restored to its normal position, the wound dried and its edges sutured together; the auditory canal being packed with gauze. (3) *A complete mastoid operation* is indicated if marked obstruction of the external meatus exists in a case of middle ear suppuration and is imperative if there are symptoms of retention of pus.

Difficulties of the operation.—This operation should not be lightly undertaken as it is often very difficult, and the results are not always satisfactory.

(1) If the exostoses are deeply situated, the tympanic membrane may be injured, resulting in middle ear suppuration.

(2) When the growths spring from the anterior border, owing to the incision in the posterior wall and the necessary wounding of the anterior wall to remove

the growth, in spite of the greatest care, stenosis may occur.

(3) If the growths are multiple and completely hide the deeper part of the auditory canal, it may be found on operation that they extend down to the tympanic membrane, and their removal is a matter of extreme difficulty.

Diagnosis.—Exostoses have to be diagnosed from (1) *Furunculosis* with which condition they can only be confused if the epithelial covering is inflamed and of a pinkish colour; probing may be painful, but not so painful as in furunculosis; an exostosis is always hard to the touch.

(2) *Foreign body.*—The history of the case and careful inspection should prevent this mistake.

ECZEMA OF THE EXTERNAL MEATUS.—It is generally an extenson of eczema of the auricle, but may occur independently. In the **acute stage** the symptoms are those of discomfort and irritation in the ear, accompanied by a sensation of heat and tenderness.

Objective signs.—In the early stage, the meatus is swollen and congested; groups of vesicles appear which rapidly burst and give rise to a slight serous exudation. Later, the auditory canal is found covered with scales of desquamating epithelium or crusts. A neglected eczema may end in acute purulent inflammation of the external meatus.

Treatment.—Like eczema elsewhere, the principles of treatment are "soothing and sealing." Syringing out the ear, or washing it with water, is to be avoided. In the earliest stage it is sufficient to mop out the meatus with pledgets of wool, and then to insert a strip of gauze impregnated with a powder consisting of one part of calomel, two parts of zinc oxide, and three parts of starch. If crusts are present they should be softened by inserting into the meatus pledgets of wool soaked in oil consisting of one part of oleate of mercury and three parts of olive oil; the oil is put into the ear at night and next morning the secretion is syringed out with a 1 per cent. solution of creolin. The meatus is then dried and dusted with the powder. In less acute cases the auditory canal may be packed with gauze soaked in a lotion of calamine. The lotion consists of :—

Calamine	30 grains
Oxide of zinc	20 grains
Glycerine	½ drachm
Water	to the ounce

or the surface of the auditory canal may be painted over with an ointment of lead and mercury :—

Subacetate of lead	2 grains
Zinc ointment	2 drachms
Calomel ointment	1 drachm
Nitrate of mercury ointment . .	20 grains
Lard	to an ounce

In the **chronic stage** there is often considerable desquamation of the epithelium, which is shed in scales. The meatus may become much narrowed from general thickening of the subcutaneous tissues. The chief symptoms are those of itching and irritation, which may be intense.

Treatment.—If the meatus is merely very dry with slight desquamation of the epithelium, it is sufficient to prescribe a simple preparation of mercury, such as dilute nitrate of mercury ointment, which can be smeared over the surface of the auditory canal by a soft camel's hair brush or pledget of wool. Epithelial débris or crusts are best removed by the instillation of olive oil at night and syringing out the ear on the following morning with 1–2 per cent. solution of creolin. If it is essential to remove the crusts at once, they may be loosened before syringing by the instillation of hydrogen peroxide (10 vols. strength) which should be left in the ear from 10–15 minutes. After syringing the ear is carefully dried. If there is much desquamation and irritation, the application of ichthyol ointment or an oil consisting of

Oil of Cade.	1 drachm
Olive oil	3 ounces

may be found beneficial.

In some cases a better result will be obtained by painting the surface of the auditory canal once a week with a 10 per cent. solution of silver nitrate. If there is much thickening of the walls of the meatus, dilatation may be attempted by carefully plugging with gauze smeared with an ointment such as that of benzoate of zinc or carbonate of lead.

Prognosis.—Relapses are frequent. The patient should be warned not to allow water to get into the ears. If there is a tendency to gout or uric acid diathesis, general treatment should be given to remedy these conditions. Eczema of the auditory canal may be complicated by an acute septic inflammation, localized or diffuse, and stenosis may even result.

ULCERATION OF THE EXTERNAL MEATUS. — It is usually the result of an abrasion which has become septic. It may, however, occur in consequence of furunculosis or diffuse inflammation of the external meatus, syphilis, tuberculosis, lupus, variola, or as the earliest manifestation of a new growth. *In elderly persons the repeated recurrence of granulations in spite of treatment, is very suspicious of malignant disease.* In all doubtful cases a microscopic examination of a scraping should be made.

The Symptoms consist of a purulent or sanious discharge, often offensive, with occasional bleeding from the ear.

Treatment.—The ear should be dried with a pledget of wool, and the auditory canal carefully inspected. If the granulations are exuberant, they are best removed by curetting them away under a local anaesthetic. If the ulceration is superficial, its base should be touched (after thoroughly cleansing and drying the auditory canal) with some cauterizing agent such as a bead of chromic acid fused on to a probe, or with the point of a silver nitrate stick; some boracic powder should then be puffed in, and the meatus lightly plugged with a strip of gauze. On changing the dressing, which should be done daily or less frequently according to the amount of discharge, the meatus should be thoroughly cleansed, and dried before blowing in fresh powder.

NECROSIS OF THE EXTERNAL MEATUS.—This may be the result of traumatism, but may also occur in the course of middle ear suppuration, especially if it is a sequela of scarlet fever in children. The sequestrum usually consists of part of the tympanic bone ; in infants the whole of the annulus tympanicus may be exfoliated.

Treatment.—Unless the necrosed bone is lying loose within the auditory canal, forcible attempts should not be made to remove it. It is sufficient to keep the ear clean by frequent syringing with a mild antiseptic lotion. When the necrosed bone has been removed, any existing granulations should be treated in the manner already described.

DIPHTHERIA OF THE EXTERNAL MEATUS.—It seldom occurs primarily, but usually as the result of diphtheritic infection of the pharynx or middle ear. When secondary there is usually no pain ; if primary the pain may be severe. The secretion is thin and sanious. The meatus becomes red and swollen, with enlargement of the glands behind the ear and down the neck. There may be slight pyrexia.

On examination, the walls of the auditory canal are seen to be partially or completely covered by a greyish-white membrane. The forcible removal of this membrane causes bleeding and leaves behind a very tender raw surface.

Diagnosis.—This affection is diagnosed by the constitutional symptoms, by microscopic examination, and by the growth of cultures taken from the membrane. It has to be distinguished from acute diffuse inflammation of the external meatus, or from certain cases of acute suppuration of the middle ear in which the epithelial lining of the external meatus has been shed in large pieces.

Treatment.—Locally, frequent ear baths of a warm solution of hydrogen peroxide tend to loosen the membrane. After the membrane has disappeared, the instillation of drops consisting of 10 grains of boracic acid in 1 ounce of rectified spirit, hastens healing of the raw patches. Any granulations should be cauterized with silver nitrate stick or trichloracetic acid, boracic acid powder being afterwards puffed in. Constitutional treatment consists in rest in bed, injection of antidiphtheric serum and tonics.

Prognosis.—In the primary form the prognosis is good. When secondary, it is serious not only with regard to the life of the patient, but also concerning recovery of hearing. In these cases there is usually much destruction of the tympanic membrane and ossicles, and there may also be involvement of the labyrinth and mastoid cells.

As an after result of primary diphtheria of the external meatus, stenosis from contraction of the cicatricial tissue may occur.

OTOMYCOSIS (*Parasitic inflammation of the external Meatus.*—Otomycosis usually occurs in adults and chiefly amongst the poor.

It is due to the growth of a saprophytic mould of which the most common varieties are the *aspergillus niger* and *flavus*. It rarely occurs as a primary disease, but usually is grafted on some other condition, such as eczema of the external meatus. Its growth is favoured by damp or by the use of glycerine, tannin, and of oily or watery solutions.

Subjective symptoms.—There may be no symptoms except a feeling of slight irritation or obstruction within the external meatus. Occasionally, however, there is great pain and smarting from diffuse inflammation.

Objective signs. — The external meatus and drum are found to be inflamed and partially covered with a membrane which may be dotted with black or yellow spots; removal of this membrane may cause bleeding, and leave behind a raw surface. Examination of the membrane under a microscope will show the presence of spores and mycelia.

The **Diagnosis** is made from the examination of the ear, the appearance of which is characteristic, and by the microscope.

Treatment.—The ear is first syringed with some warm lotion in order to remove any secretion, and afterwards dried with pledgets of wool. The frequent instillation of an alcoholic solution of boracic acid, or biniodide of mercury (1 in 2,000), has proved most successful; good results are also said to be obtained by frequently puffing in a powder of zinc oxide and boracic acid. Watery and oily solutions should be entirely avoided.

SYPHILIS OF THE EXTERNAL MEATUS.—It is usually a secondary manifestation. At first there are greyish patches of condylomata which may result in ulcers with granulating edges giving rise to a form of acute inflammation of the external meatus. The secretion is serous or fœtid. Cicatricial contraction may eventually cause stricture of the canal.

Diagnosis.—This is usually easy, owing to the evidence of syphilis in other parts of the body.

Treatment. — In addition to anti-syphilitic treatment, the ear should be syringed out daily with lotio nigra, then dried and insufflated with a powder containing one part of calomel to two of starch.

NEW GROWTHS OF THE EXTERNAL MEATUS.—They may be *benign* or *malignant*. Of the benign growths the most common are papillomata and fibromata. They are usually small and should be excised.

Malignant growths are fortunately rare. They usually begin in the auricle and involve the meatus in the course of their growth, but occasionally the auditory canal is the primary seat of the lesion.

Epithelioma may begin in the auditory canal as an apparently simple ulcer, and can be mistaken for a polypus or granulation tissue. *Recurrence of granulations in an elderly patient after several attempts at removal is suspicious of malignancy.* In doubtful cases, microscopic examination is essential. The growth eventually involves the tympanic cavity and mastoid. Epithelioma of the tympanic cavity is also described as occurring in cases of prolonged otorrhoea, but it is uncertain in such cases whether the site of origin is in the tympanic cavity or the auditory canal.

Symptoms.—In the early stage there may only be a warty excrescence or exuberant growth, which bleeds easily, especially on probing. When the tympanic cavity is involved there is a sanious, evil-smelling discharge, with attacks of lancinating pain radiating to the head, teeth, and throat. The lymphatic glands soon become enlarged. Later there is facial paralysis from the growth extending to the inner wall of the middle ear.

Probing shows extensive bone disease of the antral and mastoid region.

Treatment.—If seen sufficiently early, complete removal of the growth should be attempted by performing the mastoid operation, and if necessary by excising at the same time the auricle and cartilaginous portion of the auditory canal.

If the glands are involved an operation will not cure, but, in spite of this, it is justifiable if the pain is intense, as after it has been performed the pain may be greatly alleviated.

Prognosis.—Although one or two cases are reported as having been cured by operation, death almost invariably soon takes place from involvement of the meninges or from an intracranial abscess ; if not, from secondary deposits elsewhere or from general cachexia.

Palliative treatment consists in keeping the parts as clean as possible, and in giving narcotics to relieve the pain.

Rodent Ulcer is not so malignant as epithelioma, as its growth is slow and the glands do not become affected. It usually begins in the auricle and extends inwards along the auditory canal eventually involving the mastoid process and later on perhaps the middle ear, but its progress seems to be arrested at the site of the tympanic membrane.

In a case on which I operated, the upper two-thirds of the auricle together with the cartilaginous portion of the auditory meatus and the pre-auricular region were involved. Probing showed extensive caries of the mastoid region, but the tympanic membrane remained intact. The auricle and surrounding parts were freely excised, and all the apparently diseased bone, including the posterior wall of the bony meatus were chiselled away. A large wound was left from which sprouted exuberant granulations. A tube was inserted into what remained of the auditory canal. The wound was dressed with compresses of boracic lint. After the first week there were daily applications of the X Ray treatment. The wound eventually healed by scar tissue, leaving a small opening leading down to the tympanic membrane, so that the patient could hear normally. Six months later the patient unfortunately suddenly died from cardiac trouble. This operation combined with X Ray treatment, however, shows the possibility, in such cases, of relieving or even eradicating extensive disease.

Sarcoma is a very rare condition. It may occur in the region of the mastoid process, and may possibly be mistaken for a mastoid abscess.

CHAPTER III

DISEASES OF THE TYMPANIC MEMBRANE

ANATOMY.—THE tympanic membrane in the adult is 10 mm. in height and 9 mm. in width, and separates the external auditory meatus from the tympanic cavity. It is placed obliquely downwards and forwards, so that the anterior inferior part of the external meatus is longer than its upper posterior portion. In adults the tympanic membrane forms an angle of 140 degrees with the roof, and an acute angle of 27 degrees with the floor of the external meatus. (See fig. 1.) In an infant it lies almost horizontally, forming an angle of 170 degrees. The membrane is inserted into the sulcus tympanicus of the tympanic ring, and where the tympanic ring is deficient above forming the *incisura Rivini*, it is directly attached to the squamous portion of the temporal bone. The membrane consists of three layers—an outer epithelial layer continuous with that of the external meatus, a middle layer of radiating and circular fibres of fibrous tissues, and an inner layer continuous with the mucous membrane of the tympanic cavity. The middle fibrous layer intimately connects the malleus with the drum; its upper fibres form two bundles which diverge from the neck of the malleus and pass to the extremities of the tympanic ring forming the "anterior and posterior folds." The small portion of the membrane situated above these folds is known as Shrapnell's membrane or "*pars flaccida*" as it contains no middle layer of fibrous tissue.

There are two sets of vessels supplying the tympanic membrane, one running downwards along the handle of the malleus and derived from the auricular branch of the internal maxillary artery; the other forming a ring of radiating vessels round its circumference, and being derived from vessels supplying the external auditory meatus.

The tympanic membrane is divided unequally into a smaller antero-inferior portion and a larger postero-superior portion by the malleus which extends downwards and slightly backwards to beyond the centre of the drum.

In addition to being obliquely placed the membrane is curved inwards forming a funnel-shaped depression which is greatest at the tip of the handle of the malleus, a point known as the *umbo*. For the purpose of description the tympanic membrane is divided into four parts by drawing two imaginary lines, one downwards along the malleus and another at right angles to it, passing through its lower extremity—thus forming the anterior-superior, the anterior-inferior, the posterior-superior, and the posterior-inferior quadrants.

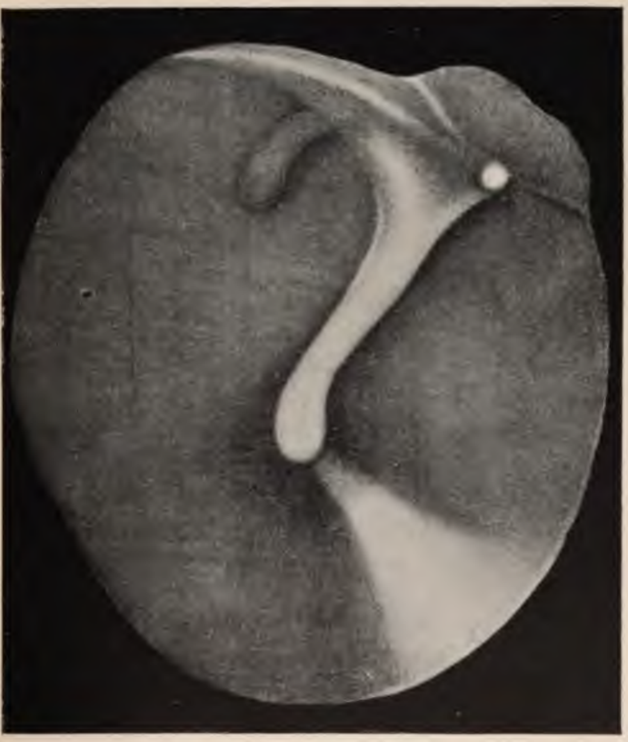
Examination of a normal membrane.—It is of a pearl-grey colour. The first point to notice is the malleus passing downwards and backwards and ending in its somewhat widened extremity. Above, the processus brevis of the malleus stands out as a whitish spot; in front and behind it are seen the anterior and posterior folds; above is Shrapnell's membrane. From the tip of the malleus a bright cone of light passes downwards and forwards to the circumference of the membrane. The light reflex is due to the inward curvature of the membrane towards the umbo so that the light falling on this part of the drum is again reflected back to the eye of the examiner. If the membrane is somewhat transparent, the long process of the incus may be seen running down for a short distance just behind and parallel to the handle of the malleus; it forms with the posterior crus of the stapes or the tendon of the stapedius muscle a "V" shaped angle. Behind and above the region of the umbo the membrane may appear somewhat lighter in colour owing to the prominence of the promontory; near the circumference of the membrane in the postero-inferior quadrant the fenestra rotunda will be indicated as a small darkened patch. At the circumference of the membrane the thickened annulus tendinosus may appear as a white band. Running backwards just below the posterior fold the chorda tympani nerve sometimes shines through as a fine whitish line.

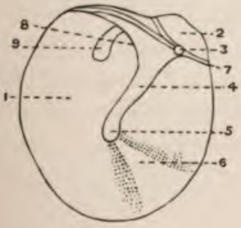
The difficulties of examination may be anatomical, or due to some obstruction of the lumen of the external meatus, such as cerumen, or from narrowing of the auditory canal as a result of eczema or an exostosis.

The inexperienced may mistake the posterior upper wall of the external meatus for the membrane itself; in many cases the membrane, owing to the curvature of the external meatus, lies further forwards than might be supposed and it may be impossible to obtain a view of its antero-inferior quadrant from narrowing of the bony canal at the isthmus.

NORMAL TYMPANIC MEMBRANE.

(From Politzer's "Wandtafeln des Gehörorganes." Wilhelm Braumüller, Vienna. By permission.)





1. Tympanic membrane.
2. Shrapnell's membrane.
3. Processus brevis.
4. Handle of malleus.
5. Umbo.
6. Light reflex.
7. Anterior fold,
8. Posterior fold.
9. Long process of incus.

[Plate VI.

ACUTE MYRINGITIS.—Although some authorities deny the possibility of the occurrence of acute inflammation of the drum as a primary disease yet such cases are met with clinically. The inner lining of the membrane is always affected in diseases of the tympanic cavity just as its outer lining is involved in any inflammatory condition of the auditory canal.

Apart from these conditions, however, cases are met with in which acute inflammation of the membrane exists without any apparent involvement of the middle or external ear.

Aetiology.—It may occur as the result of a cold wind striking the ear, from influenza, or from the outer surface of the drum being scratched by a hard substance like a hairpin.

Symptoms.—The onset is sudden, the pain being intense and neuralgic in character. Within two or three days, perhaps even a few hours after the onset, there is a slight sanious discharge with rapid relief of the symptoms. The hearing remains good, and recovery is generally rapid.

Objective signs.—In the earlier stages there is marked injection of the vessels along the malleus and its circumference. The cone of light becomes obliterated. As a rule the middle and inner layers of the membrane are not affected. As a result of the acute inflammation of the external layer there is serous exudation between it and the inner layers, shown by the presence of blebs and bullae which may be of a greyish or of a dark red or purplish colour, depending on whether they contain serous, sanious, or haemorrhagic fluid. The most frequent position of the bullae is in the postero-superior quadrant.

Hearing tests show very light loss, if any, of the hearing power. In many cases there is also involvement of the external meatus close to the membrane so that it may be difficult to distinguish where the membrane ends and the auditory canal begins. In such cases the acute myringitis is considered by some to be secondary to the acute inflammation of the external ear. After the bullae rupture, the walls collapse leaving a wrinkled surface, and the auditory canal may be found moist with serous fluid or to be partially coated with blood crusts. In some cases the contents of the bullae may become purulent.

Treatment.—In the earlier stages if the pain is not severe, it is sufficient to protect the ear by puffing in a little boracic powder, but if the pain is severe the instillation of a few drops of a 10 per cent. solution of carbolic acid and glycerine should be prescribed, together with warm dry compresses to the head. Syringing should be avoided. If there is much pain and the bullae are large or if there is any sign of the contents being purulent, they should be freely incised with a paracentesis knife, care being taken not to pierce the inner layers of the membrane. The secretion is mopped away with small pledgets of sterilized wool and a small quantity of boracic powder should then be puffed in and the ear protected by a strip of gauze. The dressing should be changed daily until all discharge ceases; this usually takes places within two or three days.

Rarely, the condition becomes chronic, granular patches forming on the upper surface of the drum; they should be treated as described under the heading of diffuse inflammation of the external ear.

Diagnosis.—Acute myringitis is diagnosed from acute inflammation of the middle ear, by the sudden onset, the absence of deafness, and the rapid recovery.

After rupture of the bullae, it is diagnosed from an acute middle ear suppuration by using Siegle's speculum.

The **Prognosis** is good. Very rarely, the membrane becomes perforated, setting up secondary acute middle ear inflammation.

TRAUMATIC PERFORATION OF THE TYMPANIC MEMBRANE.—Excepting in cases of imbeciles poking some instrument into the ear, the cause is usually accidental.

Traumatic perforation may arise in three ways :—

1. Through the external meatus—from accidentally wounding the membrane with an instrument, or from endeavouring to extract foreign bodies, or from concussion as the result of an explosion or the firing off of a large cannon. It may also be due to a blow on the ear with the hand, or from too forcible use of Siegle's speculum or the rarefacteur, but in these cases the membrane is usually atrophied, or the rupture of the drum takes place at the site of an old scar.

2. From too forcible inflation of air through the Eustachian tube into the tympanic cavity; in these cases also, the membrane is usually atrophied.

3. As the result of a fracture of the base of the skull involving the middle ear and roof of the external meatus.

Symptoms.—At the moment of the injury a loud explosive sound is heard in the ear, accompanied by severe pain, faintness, and giddiness. The deafness is slight except when the concussion has been so great as to temporarily or permanently impair or destroy the functions of the labyrinth. If the rupture has taken place through a scar or atrophic portion of the membrane, the symptoms may be very slight.

Objective signs.—The perforation is generally elliptical in shape radiating towards the circumference and situated in the inferior part of the membrane midway between the malleus and its circumference. If the perforation is due to direct piercing of the membrane by an instrument, or from rupture through an old scar, the form of the perforation may vary exceedingly. In a typical case the edge of the perforation is covered with blood crusts, and there may be ecchymoses or congestion of the tympanic membrane in its immediate neighbourhood; otherwise the rest of the membrane is usually normal. Through the perforation may be seen the normal yellowish-white colour of the promontory.

The **Diagnosis** can only be given with certainty if the patient is examined within the first few days after the lesion has taken place. After this period, as a result of inflammatory changes or cicatrization of the perforation, it may be impossible to say for certain whether the lesion was traumatic or not. This is of medico-legal importance.

Treatment.—If due to simple concussion no local treatment is required. The ear *must not be syringed* but should simply be protected by a dressing. If there is much giddiness, noises in the head, or attacks of faintness, rest in bed is indicated. If the cause is a direct injury from an instrument, special care is required to maintain asepsis; unfortunately a ddle ear suppuration is a frequent sequela, and must then be treated by the ordinary methods (see page 145).

If the concussion has been sufficiently severe to produce internal ear deafness, the patient must be kept in bed, strict quietness insisted on, and a blister applied over the mastoid process.

After a few days, if deafness still persists, strychnine should be given, beginning with 1-60th grain three times a day and increasing the dose up to 1-30th grain. If, in addition to the deafness, tinnitus persists, the application of the constant current may be tried.

Prognosis.—In a simple case of traumatic perforation the prognosis is good. Slight deafness, noises in the head, or attacks of giddiness usually shortly disappear. The course of a secondary middle ear suppuration varies, as it depends largely on the injury to the middle ear and the virulence of the infection introduced. When deafness is complete, as a result of changes within the internal ear from concussion, it may remain so permanently.

CHAPTER IV

DISEASES OF THE MIDDLE EAR

ANATOMY.—The middle ear consists of the Eustachian tube, tympanic cavity and its contents, together with the mastoid antrum and the mastoid cells.

The tympanic cavity is 15 millimetres in height, 10 millimetres in its antero-posterior diameter, and about 3 millimetres in width. Its narrowest portion is between the umbo and the promontory (2 millimetres). The upper part of the tympanic cavity is known as the "attic." It lies above the level of a line drawn horizontally between the processus brevis and the facial canal; it contains the head of the malleus and the body and short process of the incus. *Externally* the tympanic cavity is bounded, below by the membrana tympani, the least resisting of its walls, and above by the outer wall of the attic. *Anteriorly* the inner and outer walls converge, and from the upper part arises the Eustachian tube. The length of the Eustachian tube in the adult measures nearly 1½ inches, of which 1 inch forms the cartilaginous and ½ inch the osseous portion. The narrowest part of the Eustachian tube is situated at the junction of its bony and cartilaginous portions, and is called the *isthmus*. A probe introduced into the Eustachian tube will pass between the malleus and incus direct into the antrum. *Posteriorly* high up, is the opening of the tympanic cavity into the antrum through the aditus. The *aditus* is bounded by the tegmen tympani above and its floor is formed by the external semicircular canal. The *inner wall* of the tympanic cavity is principally formed by the promontory. Above the

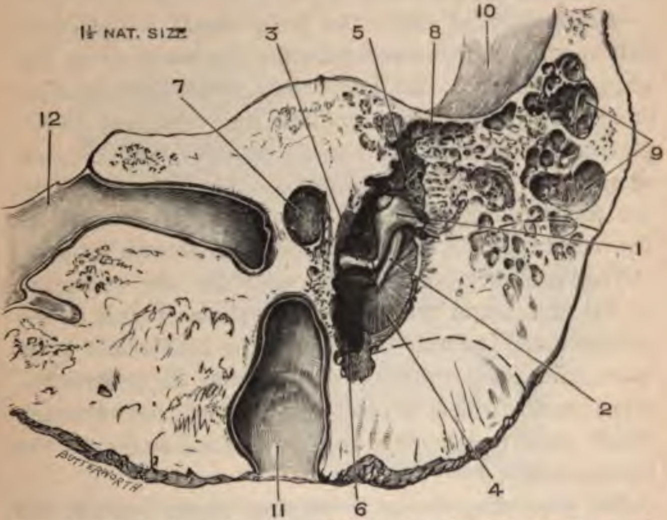


FIG. 2.—Vertical section through Ear, just behind the External Auditory Canal. (Drawn from a preparation in author's collection.)

1. Incus.
2. Malleus.
3. Stapes.
4. Tympanic membrane.
5. Attic.
6. Floor of tympanic cavity. (Note that it lies below level of the external auditory canal.)
7. Labyrinth.
8. Aditus and antrum. Above is the tegmen tympani.
9. Mastoid cells.
10. Middle fossa of the intracranial cavity.
11. Jugular fossa. (Note how closely related it is to the floor of the tympanic cavity.)
12. Internal auditory meatus.

Dotted lines show outline of external auditory canal.

promontory lies the facial canal which runs backwards to dip beneath the external semicircular canal, turning downwards and outwards in its passage to the stylomastoid foramen.

Occasionally at birth the facial canal is defective, only mucous membrane separating the nerve from the tympanic cavity; this defect may persist even in adult life. On the promontory lies the tympanic nerve plexus and over its surface fine vessels may be seen running in a vertical direction. Above and behind the promontory, lying just below the facial canal, is the fenestra ovalis, and lower down the fenestra rotunda.

The roof or *tegmen tympani*, with the exception of the membrana tympani, is the thinnest wall of the middle ear. It forms the roof of the Eustachian tube, attic, aditus and antrum; along it runs the petro-squamous suture which is patent in infancy and through which tiny vessels pass from the dura mater to the tympanum.

The floor may lie at a varying depth beneath the lower margin of the tympanic membrane. The bone separating it from the jugular fossa varies greatly in thickness and in rare cases may even be deficient; thus the bulb of the jugular vein may be separated from the tympanic cavity only by bone of the thinness of paper, or may even be in direct communication with it.

The contents of the tympanic cavity consist of the ossicles (malleus, incus and stapes) muscles, ligaments, nerves and vessels.

The function of the *ossicles* is to transmit the vibrations of sound from the tympanic membrane to the labyrinthine fluid. The ossicles form a movable chain which is fixed at three points; namely by the intimate attachment of the handle of the malleus to the tympanic membrane, by the posterior ligament fixing the short process of the incus to the entrance of the antrum, and by the attachment of the stapes to the margins of the fenestra ovalis by its annular ligament. The anterior, external, and superior, ligaments of the malleus also tend to keep it in position and limit its movements.

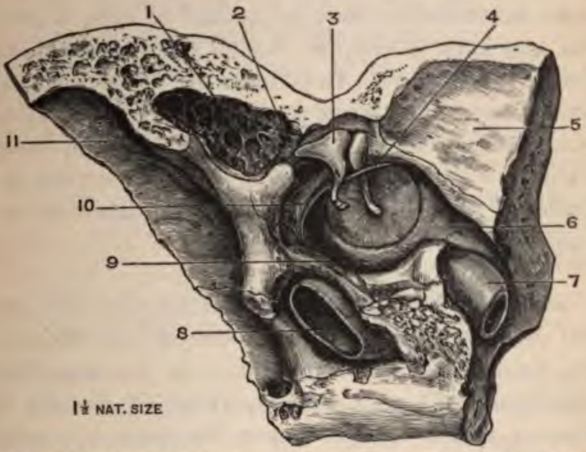


FIG. 3.—To show the anatomical relationships of the Middle Ear. (Drawn from a preparation in author's collection.)

1. Antrum.
2. Aditus.
3. Incus and malleus.
4. Chorda tympani nerve.
5. Middle fossa of intracranial cavity.
6. Eustachian tube.
7. Carotid canal.
8. Jugular vein in jugular fossa.
9. Floor of tympanic cavity.
10. Canal of facial nerve.
11. Sigmoid groove for lateral sinus.

There are two intra-tympanic muscles; the *tensor tympani* running across the tympanic cavity from the processus cochleariformis, to be inserted into the inner margin of the neck of the malleus, and the *stapedius* emerging from the apex of the eminentia pyramidalis to be inserted into the head of the stapes. These ligaments and muscles tend to divide the tympanic cavity into smaller compartments so that in some cases inflammation may be limited to only a part of the tympanic cavity, as in the case of suppuration limited to the attic. In consequence of the anatomical arrangements it is not surprising that in chronic catarrh, as a result of the general thickening of the mucous membrane and hypersecretion, there is a very great tendency for adhesions to take place within the tympanic cavity.

GENERAL CONSIDERATIONS.—Of all the diseases of the auditory apparatus, affections of the middle ear are by far the most frequent. *It is impossible to emphasize sufficiently the importance of treating these diseases in their earliest stages,* for there is no doubt that loss of hearing or even death occurs in cases which might have been cured by timely treatment.

The middle ear is lined by mucous membrane which is directly continuous with that of the pharynx through the Eustachian tube. The inflammatory processes affecting its lining mucous membrane are similar to those occurring in the mucous membrane of any other organ; every possible gradation from the mildest catarrh to the severest form of inflammation may occur. A catarrh may end in an acute inflammation or suppuration, or, on the other hand, an acute inflammatory process may subside and afterwards produce a simple catarrh. For this reason an arbitrary classification of diseases of the middle ear is not possible, but for the purpose of description the following is given, as it is founded on a clinical basis.

1. **Catarrhs**—
    - (*a*) Acute catarrh of the middle ear.
    - (*b*) Chronic catarrh of the middle ear.
2. **Otosclerosis** (Sclerosis of the middle ear).
3. **Inflammations**—
    - (*a*) Acute inflammation of the middle ear.
        - (i.) Acute Otitis Media (without perforation of the tympanic membrane).
        - (ii.) Acute Middle Ear suppuration (with perforation of the tympanic membrane).
    - (*b*) Chronic suppuration of the middle ear.

By "*catarrh*" of the middle ear is meant a simple and mild inflammation of the mucous membrane, without destruction of the deeper structures, and which is unaccompanied by any constitutional disturbance.

The term "*inflammation*" of the middle ear, on the other hand, is applied to the more acute and virulent forms of inflammatory changes of the mucous membrane resulting in production of a muco-purulent or purulent secretion, with possible destruction of the deeper structures, and which are usually accompanied by some constitutional disturbance.

In the examination of the patient the tests of hearing are of great importance in determining not only the amount of the impairment of hearing but also whether its cause is due to an affection of the middle or internal ear.

Inflation of the middle ear and Siegle's pneumatic speculum are also of great value, not only as an aid to diagnosis but for the purposes of treatment.

TESTS OF HEARING are applied for three reasons—(1) To tell the amount of deafness. (2) To differentiate between diseases of the conductive portion and perceptive apparatus, and (3) to see if there is improvement or not in hearing after treatment.

The hearing can be tested by several methods. By the voice, watch, tuning forks, acoumeter and Galton's whistle.

The hearing power should always be tested before treatment is begun so that its effect may be correctly estimated.

For practical purposes testing by the ordinary voice, or by whisper, is the most important. Tuning fork tests are of value in determining whether the deafness is due to disease of the middle or internal ear (that is of the conductive or perceptive portion of the organ of hearing). The high tuning forks and Galton's whistle are used for testing the upper limit of hearing. The watch and acoumeter act as controlling tests.

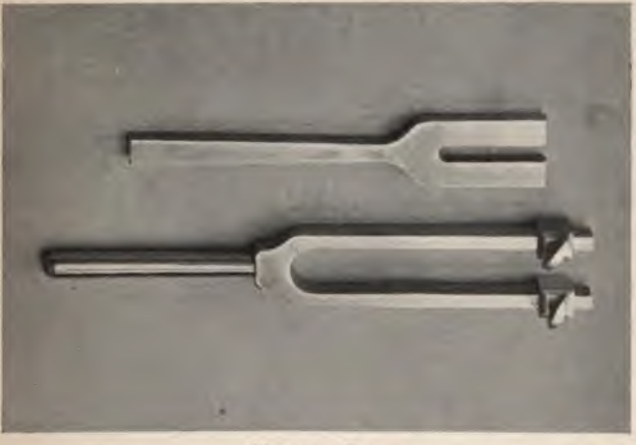
Testing by the Voice.—Unless deafness is extreme, whispered conversation should be used and practised with the same strength of voice; otherwise the test will be fallacious. Whispering can normally be heard at a distance of at least 25 feet. Some words are heard better than others. Patients suffering from nerve deafness do not hear high pitched words or tones as well as the low pitched; when the deafness is due to disease of the middle ear or to obstruction of the auditory canal, the reverse is the case. The lowest tone is R—lingual, and the highest "S." Vowels are heard better than consonants. For high tones, words such as six, sixty, sister, sailor, ship, house, mouse, may be used; they are heard badly in nerve deafness, but well in middle ear deafness. For low pitched tones the words, five, forty-five, robber, brother, rug, rabbit, may be given as examples; they are heard well in nerve deafness, badly in middle ear deafness. Words and sentences are recognized if frequently repeated, even if only incompletely heard; therefore they should be varied, and a note made of the distance at which they are heard. Numerals are better heard than words. Hesitation in answering, except in children, means that the word or sentence is not properly heard. The examination should not be too prolonged as it is very tiring to the patient.

In order that he may not lip read, the patient should sit sideways, the ear to be tested being turned towards the examiner. The other ear should be carefully stopped by the patient or an assistant inserting his finger within the external meatus, or pressing the tragus firmly over it. *Each ear must be tested separately.* The examination is begun by the surgeon standing at the extreme length of the room away from the patient and speaking in an ordinary conversational tone. If this is heard whispering is tried. The patient is approached until a distance is reached at which he can *promptly* repeat the words and sentences. In unilateral deafness if the examiner stands within three or four feet from the patient and talks in a loud voice, the voice may be heard through the other (the sound) ear even though it is firmly closed. To test whether this is the case or not, the words and sentences are repeated with both ears carefully closed. If the words are now heard to the same extent as before, it proves that the words in the first instance were heard through the sound ear.

The watch.—The tick of the watch varies in its pitch and loudness, so that the same watch should always be used. In testing with the watch it should be held far away from the ear and gradually brought closer to it, the patient making a sign as soon as the watch is heard. A rough test for distinguishing between an internal and middle ear deafness is to place the watch in contact with the mastoid process or temple; if the tick is well heard through the bone, internal ear deafness may be practically excluded. This only applies to people under 60 years of age, as with advancing years bone conduction becomes diminished.

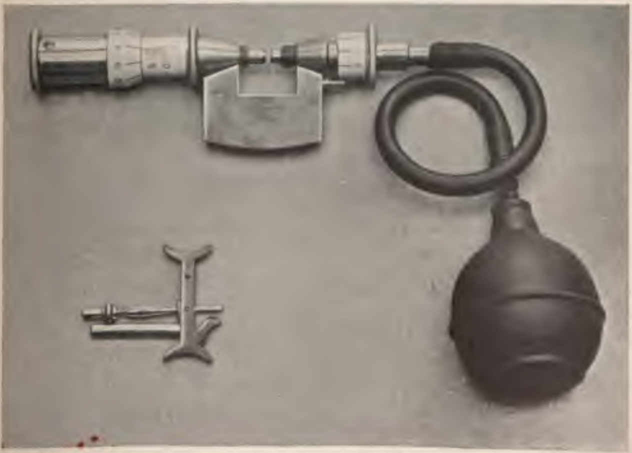
Politzer's acoumeter is a mechanical contrivance in which a small steel hammer is made to fall from a given height on to a steel cylinder. The act of contact produces a tone corresponding to c^2 (512 vibrations). The object of this instrument is to mechanically produce a note of constant pitch and intensity. The average normal hearing distance for the acoumeter is 15 metres.

Tuning Forks.—To accurately and scientifically test the complete range of hearing, as in cases of obscure central or internal ear deafness, or to test the residual hearing power of a deaf-mute, a large series of tuning forks is required. For ordinary purposes, however,



TUNING FORKS.

1. High tuning fork. c^4. 2,048 vibrations.
2. Low tuning fork. c^1. 256 vibrations.



1. EDELMANN-GALTON'S WHISTLE. 2. POLITZER'S ACOUMETER.

[Plate VII.

three are sufficient :—c^4 (2,048 vibrations) to test high tones, c^2 (512 vibrations) for middle tones, and c (128 vibrations) for the low tones. Tuning forks of low pitch should have clamps on their prongs to prevent the production of over tones.

The vibrations of sound reach the labyrinth by two ways ; (1) through the air, setting up vibrations of the tympanic membrane and the chain of ossicles, the stapes transmitting them to the labyrinthine fluid, and (2) by bone conduction through the skull direct to the labyrinth; but some of these sound waves are probably reflected back into the middle ear again and thence through the chain of ossicles to the internal ear.

By means of tuning forks the hearing power is tested both for air and bone conduction.

(1) **Weber's test.**—The tuning fork is held by its shaft and made to vibrate by striking the prongs gently against the palm of the hand ; the end of the shaft is then applied to the middle of the forehead. Normally the sound is conducted to both ears. In unilateral deafness the sound is better heard in the deaf ear if the conductive portion (middle ear deafness) is affected. In disease of the perceptive portion (nerve deafness) the sound is better heard in the normal ear.

Weber's test is more applicable for testing unilateral than bilateral deafness.

(2) **Schwabach's test.**—Schwabach discovered that, in diseases of the conductive portion, bone conduction was increased, but in diseases of the perceptive portion, bone conduction was diminished. In testing for bone conduction the tuning fork should be held at right angles to the surface of the head, and the end or foot-

piece gently pressed against the body of the mastoid process just behind and above the external auditory meatus, care being taken that the tuning fork does not touch the auricle. When the patient no longer hears the tuning fork it is rapidly transferred to the mastoid of the surgeon and the number of seconds that he hears it longer than the patient is noted; supposing the examiner hears the tuning fork 10 seconds after the patient ceases to hear it, this is described (with regard to the patient) as "*Schwabach* —" 10 seconds. If, on the other hand, the examiner does not hear it after the patient ceases to do so, it may be that the bone conduction of the patient is greater than normal; in such cases the tuning fork is first placed on the mastoid process of the examiner until he ceases to hear it, and then it is transferred to the mastoid process of the patient; the result is noted in seconds, "*Schwabach* +." For this test it is best to use c^1 or c^2 tuning forks.

(3) **Rinne's test** is a comparison of the bone and air conduction. A tuning fork of low or medium pitch is held with its shaft in contact with the mastoid process until the vibrations are no longer perceived by the patient. It is then rapidly transferred to the front of the ear so that the vibrating ends are close to, but not touching the auricle. In a normal ear it will be heard for a few seconds longer in the latter position; that is the air conduction is normally better than the bone conduction. This is known as "*positive Rinne*" (*Rinne* +).

In diseases of the middle ear the air conduction is diminished and the bone conduction increased for medium pitched tuning forks so that the tuning fork is still heard when its shaft is held in contact with the mastoid process, after it has ceased to be audible in front of the ear. This is called "*negative Rinne*" (*Rinne* —). In nerve deafness, bone conduction is diminished in relation to the air conduction (Rinne +), but in comparison with a normal ear, the tuning fork is not heard for so long a period; that is, in nerve deafness "Rinne" is *positive* but *shortened*. In very slight middle ear deafness "Rinne" may be positive. In more severe cases it may be partially negative; that is, it may be negative for tuning forks up to c^1 and positive for the higher ones. In very marked middle ear deafness it may be absolutely negative. Rinne's test is especially useful in cases of severe deafness to determine whether the origin of the deafness lies in the conductive or perceptive apparatus. It is of greater value in bilateral than unilateral deafness. In old age owing to bone conduction being diminished, Rinne's test is unreliable.

In unilateral deafness of internal ear origin "Rinne" may appear negative owing to the vibrations being transmitted through the bone to the sound side, and the patient imagining that he hears it in the affected ear. This error is corrected by Weber's test. Thus, in a case of extreme unilateral deafness with definite negative Rinne, if Weber's test is negative, that is, if the vibrations are conducted to the sound ear away from the affected one, the probability is that in spite of the negative Rinne, the origin of the deafness lies in the internal rather than in the middle ear. This is confirmed if high tuning forks are badly heard on the affected side.

In mixed cases of middle and internal ear deafness Rinne's test is often uncertain.

(4) **Tests for the upper limit of hearing.** (*a*) *The high pitched tuning forks*, such as c^4, are only used for testing air conduction. The affected ear is tested in comparison with the normal ear. In middle ear deafness high tuning forks are well heard; in internal ear deafness they are badly heard.

(*b*) *Edelmann-Galton's Whistle* is a mechanical contrivance by which very high pitched tones (up to 40,000 vibrations) can be produced. By turning a screw the vibrations can be increased or diminished, increasing or lowering the pitch. It is useful for determining the upper limit of hearing. (Plate VII.)

(5) **Gelle's test** depends on the fact that increased pressure within the labyrinth tends to diminish the perceptive power of hearing. A tuning fork is placed in contact with the mastoid; Siegle's speculum is inserted into the external meatus and, on pressing the air bag, the pressure within the external ear is increased so that the tympanic membrane and ossicles are driven inwards together with the stapes, causing increased pressure within the labyrinth. During this period of increased pressure the tuning fork is not so well heard; that is, Gelle's test is *positive*. If the stapes is ankylosed, as in cases of chronic middle ear catarrh with adhesions or in otosclerosis, pressure makes no difference to the hearing as the stapes cannot be pushed in; that is, Gelle's test is *negative*. In a labyrinthine affection the hearing is diminished, but very often, at the same time, a sense of dizziness is produced.

Gelle's test is useful in cases of middle ear disease where Rinne is only partially negative; that is negative up to c^2 and positive above. If, in such cases, Gelle's

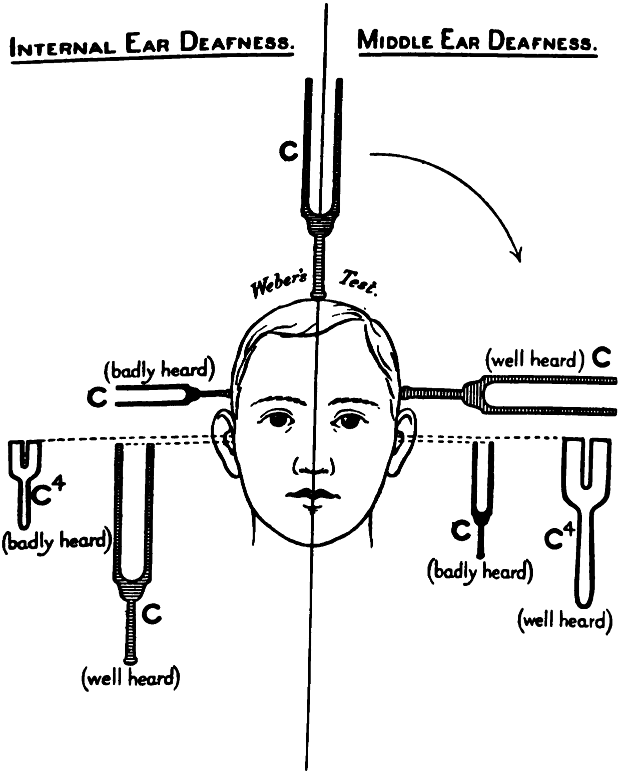


FIG. 4.—Schematic diagram to explain the tuning fork tests for Internal and Middle Ear Deafness.

Air Conduction—		
High tuning fork (c^4)	Badly heard.	Well heard.
Low tuning fork (c)	Well heard.	Badly heard.
Bone Conduction—		
Low tuning fork (c)	Badly heard.	Well heard.
Rinne's test . . .	Positive (but shortened).	Negative.
Weber's test . . .	Heard on opposite side.	Heard on same side.

For more graphic description, the tuning fork has been drawn *large* when well heard, and *small* when badly heard.

test is positive, the stapes is movable; if, however, Gelle's test is negative, the stapes is assumed to be fixed.

In order to form a correct diagnosis, the results of all the tests of hearing have to be taken into consideration.

To sum up; in a **middle ear deafness** "Weber" is referred to the affected side, bone conduction is increased, "Rinne" is negative, high pitched tuning forks are well heard, but low pitched tuning forks badly heard through the air, Gelle's test is positive, except in cases of fixation of the stapes, when it is negative.

In internal ear deafness, "Weber" is referred to the sound side, bone conduction is diminished, "Rinne" is positive and shortened, tuning forks of high pitch are badly heard and those of low pitch are well heard through the air, and Gelle's test is positive.

The two most characteristic signs of internal ear diseases are *marked* loss of bone conduction, and *marked* diminution of hearing for high pitched tuning forks in comparison with low pitched ones.

INFLATION OF THE MIDDLE EAR is the name given to the forcible introduction of air into the tympanic cavity through the Eustachian tube.

Three methods may be employed:—(1) Valsalva's method; (2) Politzer's method; and (3) The Eustachian Catheter.

1. **Valsalva's method,** or auto-inflation. The patient gives a forcible expiration, the mouth and nose being kept closed. This increases the pressure in the post-nasal space, so that the air is driven into the

Eustachian tube and tympanic cavity. Patients should be warned not to practice this method, as they get into the habit of doing it too frequently, with the result that the tympanic membrane may become relaxed.

2. **Politzer's method** consists in the mechanical forcing of air through one of the nostrils, the other being compressed whilst the patient performs the act of swallowing. As the air cannot escape from the nostrils, and as the act of swallowing raises the palate up against the posterior wall of the pharynx, thus shutting off the post-nasal space from the pharynx and the mouth, the increased pressure in the post-nasal space tends to force the air through the Eustachian tube into the tympanic cavity.

Technique of Politzer's Method.—The source of compressed air is a rubber bag of 8–10 oz. capacity to which is attached a glass or vulcanite nozzle which fits into the nostril. For convenience, a rubber tube may be used connecting the bag and the nozzle. In order to recognize the entry of air into the Eustachian tube and tympanic cavity, a diagnostic tube, consisting of a rubber tube with an olive-shaped perforated tip of ivory or vulcanite at each end is used, one end being placed in the patient's ear, the other end in the corresponding ear of the surgeon. A sip of water is held by the patient in his mouth. The nozzle of the air bag is inserted into one nostril and held in position by the finger and thumb of the left hand, which at the same time pinches the nostrils together. At a given signal the patient swallows the water, and simultaneously the air bag, which is held firmly in the right hand, is forcibly compressed. The proper moment to press the bag is when the larynx is seen to rise during the act of deglutition. If the inflation is successful a gurgling sound will be noticed, and if the Eustachian tube is patent, the air will be heard (by means of the diagnostic tube) to enter the tympanic cavity. By adults the sensation of air entering into the tympanic cavity is described as a crackling or loud explosive sound; children may cry out and suddenly put their hands up to the ears. In children the swallowing of water is not necessary, and crying facilitates the procedure.

Politzer's method may be used instead of catherization :

(1) In small children.

(2) When both ears are affected.

(3) If owing to nasal obstruction the passing of the catheter is very difficult, and causes pain.

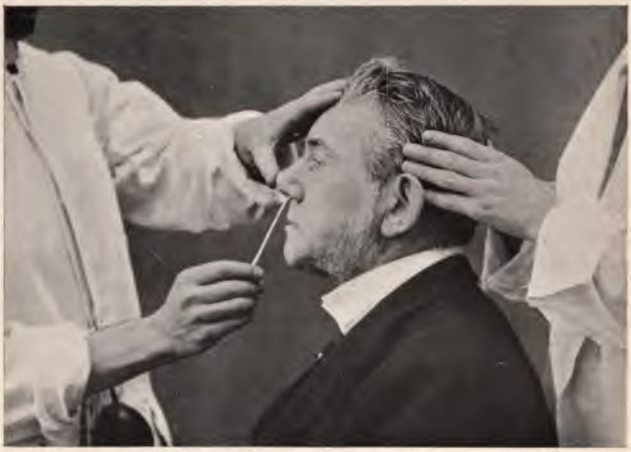
(4) In nervous individuals who object to the catheter.

(5) By those who are not adepts at passing the catheter; Politzer's method is not so dangerous, and can be more easily applied.

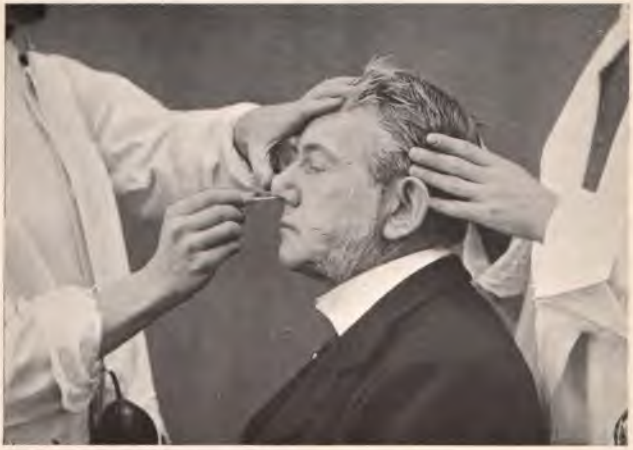
(6) When the sudden inflation by means of Politzer's method is more effective than that produced by catheterization.

(7) In certain cases when the patient cannot obtain the service of a medical man, but where it may be necessary to inflate the ears periodically.

3. **Catheterization** consists in passing a catheter through the nose into the post-nasal space, so that its tip engages within the orifice of the Eustachian tube, and then forcing compressed air through it into the middle ear. The source of compressed air may be a Politzer's bag with a tube attached. Instead of



1. Introduction of Catheter.



2. Passing Catheter through Nose.

METHOD OF PASSING THE EUSTACHIAN CATHETER.

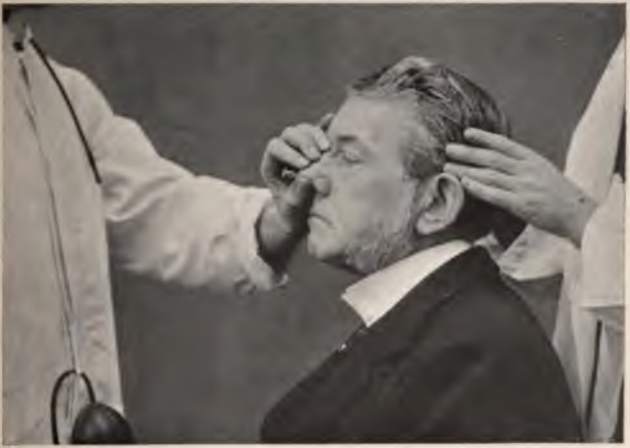
[*Plate VIII.*

having a nozzle at its extremity it is fitted with a vulcanite tip, whose point accurately fits into the wider extremity of the Eustachian catheter. A short silver or plated catheter is the best. It is five inches in length with a curve at its extremity. Catheters vary in diameter from No. 1 to No. 4 English size (same scale as urethral catheters). To indicate the position of the point of the catheter in the post-nasal space, a ring is attached near to its wider extremity corresponding with the concavity of the curvature of the beak of the catheter. The possibility of infection by means of a dirty catheter can be best avoided by sterilizing in boiling water *before* and *after* use.

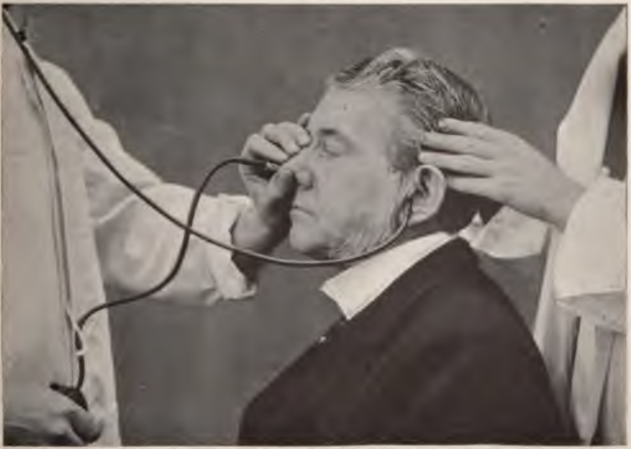
Technique of Catheterization.—The patient is seated facing the surgeon ; the head should be supported by a prop or by an assistant. Except when it is contra-indicated, it is wiser to spray into the nose a very small quantity of 2–5 per cent. solution of cocaine or eucaine. Catheterization is best performed with the surgeon standing up in front of the patient. One end of the diagnostic tube is placed in the patient's ear, the other end in the corresponding ear of the surgeon. For the sake of convenience, the air bag is suspended from a button of the coat of the surgeon by means of a loop of tape fixed to its tubing. The catheter is held lightly at its wider extremity, with its beak turned downwards, between the thumb and first finger of the right hand, whilst the tip of the nose is tilted up by the thumb of the left hand. As the point of the catheter is inserted into the nostril, the right hand should be kept low down, so that the stem of the catheter is almost in a vertical position, and its tip lies on the floor of the vestibule.

The catheter is then *gently* pushed through the nose, the right hand being gradually raised so that the catheter passes along the floor of the nose in a horizontal position. When the catheter reaches the post-nasal space it will be felt to glide over the soft palate. In a normal nose, even without using cocaine, this procedure, if performed gently and quickly, is accompanied by very little discomfort. The catheter is now pushed backwards until it reaches the posterior wall of the naso-pharynx; the beak is then rotated inwards towards the opposite side (shown by the ring at its outer extremity) and withdrawn until it is felt to catch against the posterior edge of the vomer. It is now slightly pushed backwards to free it from the soft palate, and rapidly rotated downwards and then round in an outward direction until the ring points to the outer canthus of the eye on the side to be catheterized. The point should now engage within the Eustachian tube. This is the most certain method for those who have not had much experience of catheterization.

Another method, which is very simple after practice, is to rapidly and gently pass the catheter along the inferior meatus of the nasal fossa, at the same time tending to rotate the beak outwards, which will take place as soon as it has passed behind the level of the inferior turbinate into the post-nasal space. The tip of the catheter will then revolve outwards and upwards and enter the Eustachian tube which lies behind and just above the posterior end of the inferior turbinate bone. In order to retain the point of the catheter in position, it should be slightly withdrawn and kept in a fixed position by means of the thumb and finger of the



3. Catheter in position.



4. Act of inflation.

METHOD OF PASSING THE EUSTACHIAN CATHETER.

[*Plate IX.*

left hand. *When the catheter is once in position, the left hand should not be moved until the act of inflation is completed.*

Catheterization is preferable to Politzer's Method:—

(1) As a means of diagnosis in order to tell more accurately the position and amount of obstruction in the Eustachian tube, and also the character of the fluid which may be present in the middle ear.

(2) When only one ear is affected.

(3) For the purpose of treatment. (*a*) Through the catheter medicated drops can be instilled or medicated vapours blown into the Eustachian tube and tympanic cavity. (*b*) In order to pass bougies into the Eustachian tube. (*c*) For the purpose of washing out the tympanic cavity by syringing fluids through the Eustachian tube.

(4) If, instead of an india-rubber bag, a cylinder containing compressed air, to which is attached a Globe Multi-Nebulizer, be used, medicated vapours at any given pressure and for as long a period as desired can be introduced into the Eustachian tube; this method often gives better results than those produced by simple politzerization or catheterization.

Points to notice before inflation.—(1) Care must be taken that the lumen of the catheter is not obstructed, and that the compressed air-bag and auscultation tube are in working order.

(2) The patient should gently blow the nose to clear it of all secretion. *If the nose is filled with crusts or is in a septic condition, inflation should be avoided.*

(3) The patient should be sitting down, never standing up: sometimes on inflation of the ear, especially for

the first time, an attack of giddiness or faintness may occur.

(4) In order to prevent muscular contraction of the palatal muscles, which may grip the end of the catheter and prevent its insertion into the orifice of the Eustachian tube, the patient should be told to breathe quietly and keep the eyes open.

(5) In order to test the value of this method of treatment, and also from the point of view of prognosis, the hearing should be carefully tested before and after inflation.

Difficulties of Catheterization.—(1) Irritability of the mucous membrane. This may partly be due to nervousness. The passing of the catheter may set up a violent spasm of sneezing or coughing, or (when the catheter reaches the post-nasal space) cause such intense contraction of the palatal muscles as to render movement of the catheter impossible. Usually the application of cocaine or eucaine will remove these difficulties.

(2) Nasal obstruction. If due to a deviated septum or spur, this may be overcome by introducing the catheter with its stem held upwards and outwards so that the beak of the catheter on entering the nose may dip in beneath the anterior end of the inferior turbinate. As the catheter is gently pushed backwards the right hand should be brought round with a circular movement, so that the beak gradually points downwards. The hand is then raised as in the former method, until the catheter lies in a horizontal position. In every case, before catheterization, it is wiser to inspect the nose to see if any

obstruction exists. If the nose is narrow and there is a possibility of the passing of the catheter causing pain, in addition to spraying in a little cocaine, some more cocaine solution may be rubbed along the inferior meatus by means of a pledget of wool on a probe. The catheter itself should be passed under actual inspection, by the use of a nasal speculum and reflected light. In no case must the catheter be forced through the nose. Sometimes the difficulty of obstruction is overcome by diminishing the curve in the catheter. If the nasal obstruction is great, whether it is the result of adhesions, old ulcerations, or bone deformity, it may be necessary to pass the catheter from the other side. In this case a longer catheter must be used with a bigger curve. When it reaches the post-nasal space its tip is turned towards the opposite side to that through which it has been passed.

(3) Catheterization may be rendered difficult by the presence of a large pad of adenoids or a tumour in the post-nasal space, or inflation of air into the Eustachian tube may be quite impossible from occlusion of the pharyngeal orifice of the Eustachian tube as the result of previous ulceration.

(4) Occasionally the point of the catheter lies in Rosenmüller's fossa behind the Eustachian tube; in such cases sounds may be referred to the ear and the inexperienced examiner may imagine that the catheter is lying correctly within the Eustachian tube. The sound is always soft and distant; in cases of doubt inflation should be gently practised once or twice with the catheter in varying positions. When the catheter is in the correct position, the patient should be able

to talk without discomfort, and there should be no tendency to retch nor cough.

Mishaps occurring during inflation. — If the inflation is too forcible, it is possible *to rupture the tympanic membrane;* this, however, is rare except where the membrane is partially atrophic or replaced by a thin scar. As a result of catheterization, *severe epistaxis* may be produced; or *surgical emphysema* from the point of the catheter having lacerated the mucous membrane, and air having been forced into the sub-mucous tissue. This is more likely to occur after forcible attempts to pass a bougie into the Eustachian tube.

The symptoms of surgical emphysema are sudden pain, perhaps accompanied by difficulty in swallowing or dyspnoea if the emphysema has extended towards the larynx; there may also be swelling of the soft palate or of the neck, accompanied by distinct crepitation on palpation.

Treatment of surgical emphysema.—The patient should be calmed of his anxiety, which is often intense. Ice should be sucked. All sneezing, coughing, or blowing of the nose should be avoided as far as possible. If the emphysema is marked, it may be necessary to scarify the pharynx and soft palate with a small bistoury. The diet should be liquid and cold. Recovery may be hastened by gentle massage of the neck and face. No further attempts at inflation should be made for at least eight days.

The following are the usual sounds heard through the diagnostic tube.

1. A soft blowing sound—in the normal ear; it

varies in loudness according to the size of the catheter and Eustachian tube.

2. A distant, slight sound, followed by a click and sudden loud blowing. This may be one of two conditions (*a*) a tubal catarrh ; (*b*) a retracted drum lying against but not adherent to the inner wall of the tympanic cavity. In the former case the air entry suddenly makes the Eustachian tube patent ; in the latter it forces the tympanic membrane away from the promontory.

3. Moist crackling sounds, when the tympanic cavity contains exudation.

4. Rough irregular sounds, in chronic middle ear catarrh with adhesions and with thickening of the mucous membrane.

5. Loud hissing sounds, heard close to the ear, or high pitched squeaking sounds, which may be heard without the diagnostic tube, are pathognomonic of a perforation.

6. Distant sounds, especially if increased pressure is required to cause air entry into the tympanic cavity, means obstruction of the Eustachian tube.

7. Very loud sounds occur in abnormal patency of the Eustachian tube, as in otosclerosis.

Although the catheter may be in the correct position, sounds may not be heard through the auscultation tube (1) If the catheter or auscultation tube are blocked, or if the examiner's or patient's ear is filled with impacted cerumen or otherwise obstructed. (2) If the middle ear is filled with thick, tenacious exudation, it may be impossible to force air through it.

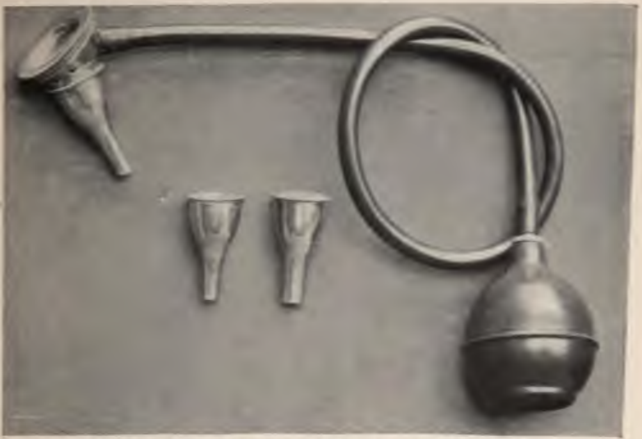
Siegle's pneumatic speculum consists of an aural speculum which fits accurately into an end-piece, whose extremity is covered by an obliquely placed glass disc or lens; from the side of this end-piece a nipple projects, to which is attached a rubber tube and ball.

If the speculum is inserted into the external meatus so as to accurately fit it, compression of the ball increases the pressure of the air within the meatus, and the tympanic membrane is driven inwards; if introduced into the meatus with the ball tightly squeezed in the hand and if, after insertion, the hand is gradually relaxed, the ball tends to fill with air and diminish the pressure within the external meatus, thus drawing the tympanic membrane outwards.

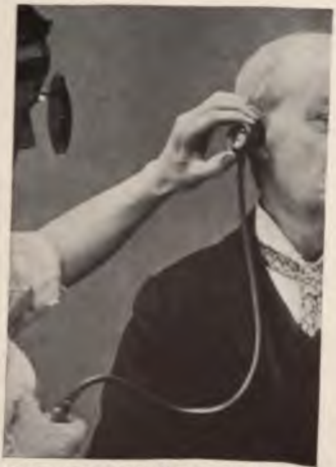
The glass disc or lens is placed obliquely in order to prevent the reflection of light from the head mirror, rendering a view into the meatus impossible. The specula, which can be removed from the end-piece, are of various sizes; like the end-piece, they are now made of metal, in order to facilitate sterilization after use.

Methods of use.—The speculum chosen should accurately fit into the external meatus. The instrument, before use, is warmed over a spirit lamp, in order to prevent the warm and moist air in the auditory canal dimming the glass. Before inserting the speculum into the meatus the ball is slightly compressed; by relaxing or still further pressing the ball the pressure within the meatus may be either diminished or increased.

Normally, the greatest mobility of the tympanic membrane is in the region between the malleus and the periphery, especially in the postero-superior quadrant.



SIEGLE'S SPECULUM (*Peters' modification*).



METHOD OF USING SIEGLE'S SPECULUM.

(Plate X.

On increasing the pressure, as the tympanic membrane is driven in, the malleus moves backwards and inwards, and the cone of light gets smaller; on diminishing the pressure the malleus and the cone of light resume their normal position.

Uses of Siegle's speculum.—(1) *Diagnostic.* (*a*) The degree of mobility of the tympanic membrane can be observed; whether the membrane is thickened or relaxed with its movement impaired or exaggerated. (*b*) In cases where the membrane is retracted or partially replaced by a scar, diagnosis can be made whether it is free, or partially or completely adherent to the inner wall of the tympanic cavity. (*c*) Non-adherent scars and atrophic patches being of thinner consistence than the rest of the membrane, show depressions on increasing pressure, and bulging outwards on diminishing pressure.

(2) *Therapeutic.* (*a*) To suck out the secretion from the tympanic cavity. (*b*) By alternating the compression and relaxing the ball, Seigle's speculum may be used as a masseur. (*c*) By inserting the speculum with the ball compressed, and then relaxing it and keeping it in this position, Siegle's speculum can act as a *rarefacteur*.

ACUTE MIDDLE EAR CATARRH

Acute middle ear catarrh is the result of a post-nasal catarrh which has spread by direct extension along the Eustachian tube to the tympanic cavity.

The most important predisposing causes are adenoids in children and nasal obstruction in adults; the exciting cause in nearly every case is a cold in the head. Other causes which may be mentioned are influenza, syphilis, and the specific fevers, but the latter, especially scarlet fever, diphtheria and enteric fever, more often give rise to acute middle ear suppuration.

Pathology.—The pathological changes vary according to the intensity of the catarrh. The mucous membrane becomes hyperaemic and swollen, and a clear serous or viscid fluid may be secreted in varying quantity from its surface. As a rule the whole tract of the middle ear is involved. When the secretion is abundant and serous in character, the condition is known as a *serous catarrh*. Occasionally, the swelling of the mucous membrane and hyper-secretion may remain limited to the pharyngeal end of the Eustachian tube obstructing its lumen, without involving the tympanic cavity; this is called *tubal catarrh*. In the early stages of tubal catarrh, the tympanic cavity may show no pathological changes, but later, if recovery does not take place, its mucous membrane usually becomes involved either by direct extension, or from a condition known as "hydrops ex vacuo."

If the Eustachian tube remains blocked, the middle ear is converted into a closed cavity. The air within it is gradually absorbed so that the air pressure in the middle ear tends to fall below that of the atmosphere, in consequence of which the tympanic membrane becomes gradually indrawn towards the inner wall of the tympanic cavity, and at the same time passive exudation of fluid may take place from the surface of the mucous membrane.

Symptoms.—There is generally a feeling of discomfort and fullness in the ear, which at the onset may be accompanied by some twinges of pain. Except in infants, in whom the slightest form of middle ear catarrh may give rise to recurrent attacks of earache, pain is generally absent. The deafness varies, often with extreme suddenness. At one time the patient may only feel somewhat stuffy and stupid in the ear, but nevertheless may hear fairly well; at another time he may suddenly become deaf as though the ear had been filled with water or stopped up by the finger. Perhaps, again, after eating or blowing the nose he may hear a click or crack in the ear, and the deafness may temporarily diminish or disappear. These changes are due to the Eustachian tube being at one time patent, and at another being suddenly occluded by the swollen mucous membrane or a plug of mucus. If there is much viscid secretion, the deafness may be very pronounced; if the secretion is serous, the deafness may come and go as the patient lies down or stands up owing to the fluid in the middle ear altering its position, and with this there may be a feeling of something moving in the ear.

Occasionally the patient complains of buzzing or singing in the ear (*Tinnitus*), which may cause more annoyance than the deafness.

Another subjective symptom which is often of a very disagreeable nature, is an increased resonance of the voice in the head (*Autophonia*); this may be so marked that the patient imagines he is talking in a loud manner, and in consequence shuns general conversation.

Simple middle ear catarrh may affect one or both ears, but if both, then the affection of one side usually precedes that of the other.

Appearance of the membrana tympani.—This varies according to the character and intensity of the catarrh. There may be no appreciable change in the milder forms, especially if the result of a tubal catarrh, or if the drum is somewhat thickened or opaque as a result of a previous attack. Usually the vessels along the malleus and at the circumference of the drum are slightly injected, its surface may appear more glistening than usual and of a yellowish red or brownish colour. If the condition has existed for a little time the membrane becomes somewhat indrawn with foreshortening of the malleus, the cone of light being altered or broken and the surface of the drum itself appearing dull and sodden. (Plate XII, 12.) In cases of serous effusion, especially if the drum is thin and transparent, the exudation may be actually seen within the tympanic cavity, and its level to be sharply marked off from the upper portion of the tympanic cavity by a line of demarcation often compared to the appearance of a hair. (Plate XII, 3.) This line is usually curved upwards, and is higher behind than in front of the malleus; occasionally the level of the fluid may be seen to change its position as the head is moved backwards and upwards or downwards and forwards. The colour of the membrane below the level of the fluid is usually darker. If the whole cavity is filled with fluid there is, of course, no line of demarcation, but there is often slight bulging of the membrane especially in its upper and posterior quadrant.

Examination of the nose and post-nasal space.—In almost every case there is evidence of post-nasal catarrh or of adenoids, or of a general catarrh of the nose, naso-pharynx and pharynx. Sometimes there is considerable swelling of the pharyngeal end of the Eustachian tube. In a few cases a fibroma or other growth may be found encroaching on the Eustachian tube, or there may be paralysis of the palatal muscles the result of diphtheria.

Tests of hearing show the presence of middle ear deafness. Rinne's test is negative; Weber's test shows bone conduction conducted towards the affected side; tuning forks of high pitch are well heard through the air, but those of low pitch are heard badly. In the slightest forms of catarrh, "Rinne" may be positive. The watch is always heard when placed in contact with the bone, but usually only a few inches from the ear.

Diagnosis.—The diagnosis is made from the history of a recent cold followed by deafness which, although attended by discomfort, is not accompanied by earache. The changes in the tympanic membrane are slight, and there is usually improvement in hearing after inflation.

Treatment.—The principles of treatment consist in endeavouring to restore the patency of the Eustachian tube, and to remove the secretion from the tympanic cavity, and at the same time to treat the actual cause of the catarrh, whether it is due to some naso-pharyngeal affection, or to a general disease. If the patient is suffering from a severe cold in the head, it is wiser to insist on his staying in one room at an even temperature for the first few days. In a mild case this is not necessary. The diet should be light, and a smart purgative given at the beginning of the treatment is always beneficial.

Local treatment.—The ear must not be syringed. It is sufficient to instil into the auditory meatus a few drops of a 10% solution of carbolic acid in glycerine; this may be repeated twice or three times a day. In order to instil the drops the patient's head should be placed in a horizontal position with the affected ear uppermost.

A teaspoon should be dipped into very hot water and rapidly dried; the drops are then poured into the teaspoon and its tip inserted into the meatus in such a fashion that the drops are poured from it into the auditory canal. (N.B. *The drops or lotion should always be at the temperature of* 100° *Fah.*) To make the drops reach the surface of the drum, the finger should be pressed on the tragus several times rapidly in succession. The meatus should then be plugged with a small piece of cotton wool. As a rule further local treatment to the ear is unnecessary. The drum, however, should be inspected daily, in case what at first seemed to be a simple middle ear catarrh may really be the beginning of an acute middle ear inflammation. If this takes place the drum will be found to become more congested, and to be accompanied by acute earache. As the catarrh subsides the slight congestion of the drum will be found to diminish.

In order to restore the patency of the Eustachian tube and to get rid of any secretion from the middle ear, it is necessary to employ one of the methods of inflation. As a rule Politzer's method is sufficient.

Inflation of the middle ear should not be done until the acute nasal and post-nasal catarrh has passed off. Also it is wiser to postpone it until at least 84 hours have passed since the last twinge of earache.

If there is exudation within the tympanic cavity, crackling and bubbling sounds may be heard on inflation; they gradually diminish as the exudation gets absorbed. In tubal catarrh the sound may at first be distant and then followed by a sudden click and blowing noise as the Eustachian tube becomes patent; this is often well marked during the act of swallowing. Occasionally if the fluid is very thick and fills the tympanic cavity no sounds, or only distant ones, are heard.

After inflation the hearing should again be tested.—As a rule there is considerable improvement of hearing, and with this improvement the patient usually states that the head feels clearer, and that the noises and autophonia have disappeared. The improvement varies not only in amount, but also in the time it lasts. This largely depends on the character and amount of catarrh present. In a simple case of tubal catarrh, the improvement may be very great and last for several days, until the air in the middle ear again becomes absorbed with further retraction of the membrane, owing to the Eustachian tube not remaining patent. If the mucous membrane is thickened and the Eustachian tube somewhat narrow, owing to previous attacks of catarrh, the improvement may not be so great. If the secretion is very viscid there may be at first no improvement. If the middle ear is filled with serous fluid, the improvement may only last a few hours, owing to further exudation taking place.

Inflation should be repeated daily at first. If any earache is produced, it should not be repeated until two days after the earache has ceased. The frequency with which inflation has to be repeated depends on the improvement which takes place. If the improvement lasts two days, then the ear should be re-inflated at the end of the second day; when the hearing remains good for a longer period, the frequency of inflation should be diminished accordingly, until finally the patient feels quite clear in the head and the hearing remains normal. As a rule, inflations are necessary every day for the first week, every second day for the second week, every third day for the third week, and afterwards about once a week for two or three weeks. In many cases of mild catarrh hearing returns and remains normal within a very few days after the onset. Sometimes, after inflation, the increased tension of air in the middle ear produces an unpleasant feeling of fullness which can generally at once be relieved by means of gentle air massage of the drum with a Siegle's pneumatic speculum.

Sometimes, in spite of repeated inflations, the hearing does not improve, owing to the persistence of the exudation within the tympanic cavity. If absorption has not taken place within a month from the onset, it is justifiable to do a paracentesis of the tympanic membrane (*see* page 134). After this has been done, the secretion is removed either by sucking it out by means of Siegle's speculum or by expelling it out of the tympanic cavity into the external meatus by gentle politzerization. The secretion is usually viscid in character and should be carefully wiped away by small pledgets of wool, and the external meatus afterwards protected by a small strip of sterilized gauze. Gentle inflation should be practised daily, together with suction by means of Siegle's speculum, to prevent closure of the opening in the tympanic membrane: if this takes place, it may be necessary to do a further paracentesis.

In these cases Schwartze recommends the giving of calomel to promote absorption. In addition gentle massage of the side of the head and neck in a downward direction for two or three minutes several times a day is often beneficial.

For treatment of the nose and naso-pharynx, which must not be neglected, the reader is referred to Chapter XV.

In children the general condition may be improved by occasionally giving syrup of iodide of iron and the compound syrup of phosphates of iron.

Prognosis.—In the majority of cases a simple middle ear catarrh has an uneventful recovery and is cured within four to six weeks after the onset, provided the patient is healthy and the cause of the catarrh is due to some temporary condition such as a simple cold in the head or the result of bathing. If the catarrh is secondary to a nasal or post-nasal affection, the prognosis largely depends on whether these conditions can be cured. If several attacks of catarrh have previously occurred before the case comes under observation, irreparable pathological changes may have already taken place within the middle ear so that it may only be possible to restore the hearing to the same condition as it was before this last attack took place. The prognosis can generally be inferred from the result of improvement obtained on inflation.

If there is anaemia or ill-health, the prognosis is not so good. Tinnitus, although at times a very distressing symptom, is relieved and may disappear temporarily after inflation; it eventually does disappear, but in cases of influenza may persist for a considerable time after the hearing has been completely restored.

Relapses are not uncommon, especially in children, if adenoids are present.

CHAPTER V

CHRONIC MIDDLE EAR CATARRH

As has already been mentioned it is clinically impossible to sharply separate the various catarrhal affections of the middle ear, as one type may pass into the other, and occasionally mixed forms may be met with in the same case.

The clinical conditions found may be subdivided into three chief types :—

1. A chronic progressive catarrh with general thickening of the mucous membrane of the middle ear.
2. Chronic tubal catarrh with marked retraction of the tympanic membrane.
3. The results of a previous catarrh which is no longer progressive, where the Eustachian tube may be patent but adhesions bind down the tympanic membrane partially or completely to the inner wall of the tympanum.

Pathology.—A middle ear catarrh in its early stages can generally be cured, the mucous membrane again becoming normal.

If the catarrh persists, the mucous membrane remains swollen and succulent, becoming infiltrated by a round celled infiltration. In this way the depressions of the tympanic cavity, especially the niches of the fenestra ovalis and fenestra rotunda, become filled with hypertrophic mucous membrane which also envelopes the ligaments and the ossicles, limiting them in their movements and thus causing impairment in hearing.

If resolution does not now take place, the round celled infiltration becomes gradually transformed into new connective tissue, which tends to produce adhesions between the ossicles themselves and the inner wall of the tympanic cavity, and eventually to cause the stapes to become almost immovably fixed by fibrous ankylosis to the margins of the fenestra ovalis.

The membrana tympani may become very thickened or even calcified in parts, and the Eustachian tube may be much narrowed or occluded by a permanent stricture. On the other hand, from shrinking of the tissues, the mucous membrane may become thin and parchment like, and the membrana tympani atrophied in parts.

Quite apart from this catarrhal group there is another condition sometimes known as *chronic dry catarrh*, but this is now recognized as a separate disease, and is called *Otosclerosis*.

Etiology.—The onset and progress of chronic middle ear catarrh is often so gradual, and, in its earlier stages of so little inconvenience to the patient, that it may have existed for a considerable period before advice is sought; consequently, it is often very difficult to assign an actual cause for the condition. Undoubtedly the most frequent causes are a neglected acute middle ear catarrh, or a chronic tubal and naso-pharyngeal catarrh. Any condition, however, which tends to produce or maintain a congestion of the mucous membrane of the nose and naso-pharynx may be considered a predisposing cause. Thus, over-indulgence in alcohol or tobacco, especially cigarettes, or continuous occupation in a dusty atmosphere, may act as local irritants; whereas, such general conditions as gout, chronic rheumatism, Bright's disease and syphilis may act indirectly through the blood-stream. It is doubtful whether heredity plays any direct part; indirectly, it undoubtedly may do so. For instance, it is not uncommon to find adenoids, and the same type of high palate and narrow nose in several members of the same family, conditions which in themselves tend to produce chronic naso-pharyngitis and in this way middle ear disease. Chronic middle ear catarrh is an affection of adult life. One ear is often very deaf before the other is apparently affected; when, however, the sound ear also becomes involved (and this may not occur for a long period), it frequently becomes rapidly deaf and ultimately becomes the worse ear.

Symptoms.—The three chief symptoms are progressive deafness, noises in the head, and attacks of giddiness.

Deafness may have existed in one ear for a considerable time, the patient only seeking advice when the previously sound ear also begins to be affected. In other cases the deafness has been discovered accidentally. The deafness is usually progressive and may vary, being generally worse in damp weather. There is often a history of frequent colds in the head accompanied by repeated attacks of deafness. After these attacks, the hearing may again become as good as it was before, but, as a rule, with each succeeding cold the deafness increases.

The hearing is affected by mental emotions, and is often worse during the evening, or when the patient is fatigued, or for any reason is in a poor state of health.

Sometimes deafness is so great that whispering cannot be heard. In uncomplicated cases of middle ear catarrh, however extreme, there is never complete deafness, and speech can be heard by means of an ear trumpet or speaking tube. As a secondary result of chronic middle ear catarrh, the internal ear may become involved; when this happens it is possible for the deafness to become complete.

Tinnitus.—This most distressing symptom may occur long before deafness is noticed, especially in cases of otosclerosis. In cases of chronic middle ear catarrh, however, the tests for hearing usually show some diminution of the hearing power, in spite of the patient's assertion that his hearing is normal. The noises vary very much in character; they may be compared to the hissing of steam, hammering, buzzing sounds, or to a musical note of high or low pitch. At other times they are of a pulsating character. At first the noises may be intermittent, but in the later stages of middle ear catarrh they may become continuous and of such intensity as to prevent sleep and may reduce the sufferer to such a state of distress and despair as to make him contemplate suicide.

Vertigo is also a very varying symptom, and occurs in the later, rather than in the earlier stages. The attacks may, on the one hand, be so slight as to merely give rise to the sensation of a slight swimming in the head, or, on the other hand, may be so severe as to cause the patient to suddenly fall. In the severe attacks the vertigo may be accompanied by nausea or vomiting together with marked increase of the tinnitus and deafness. The giddiness may persist for some time, the patient being compelled to take to his bed. These attacks (*Menière's symptom-complex*) which very closely simulate "Menière's disease" are probably due to a sudden hyperaemia of the labyrinth, and are usually met with in the later stages of middle ear catarrh, when the stapes has become firmly fixed by means of adhesions to the margin of the fenestra ovalis.

In addition to deafness, tinnitus, and vertigo, there may be a feeling of numbness of the auricle, and of tightness in the head, and sometimes there are definite attacks of neuralgia radiating up the side of the head and over the mastoid region. At other times there may be actual pain in the ear on hearing loud noises (*hyperacusis* or *hyperaesthesia acustica*), or music may produce a disagreeable sensation, the notes being heard a half-tone too high or too low by the affected ear (*diplacusis*).

Another subjective symptom is the ability to hear better in a noise, such as when travelling in a railway train; this is known as "*Paracusis Willisii.*" This symptom (which is an unfavourable one), is usually met with in the late stages of middle ear catarrh or in otosclerosis. Various theories have been put forward to account for this peculiar condition, and it is suggested that the movement either increases the vibration of the ossicles or perhaps stimulates the nerve terminals of the auditory nerve within the labyrinth.

Objective signs. — *Appearances of the Membrana Tympani.*—The two chief pathological changes are retraction of the membrane and thickening of its substance. The retraction is due to obstruction of the Eustachian tube, and the thickening to the chronic inflammatory changes which have taken place in the mucous membrane and substance of the drum as a result of the chronic catarrh.

The drum may appear uniformly opaque and may be compared to frosted glass, the malleus appearing broader especially at the umbo. If the thickening is not uniform, the thickened patches either appear as whitish striae with a greyish background or they may be semilunar in shape lying midway between the margins of the drum and the malleus. Rarely, chalky deposits are seen taking the form of crescents or round white spots. The chalky deposits may be distinguished from the thickened patches in that their outline is sharply defined from the surrounding membrane, and that they are of a more intense white colour. (Plate XII, 7.)

Sometimes, instead of there being thickening of the drum there may be partial atrophy. These atrophic patches are small, appear darker in colour than the surrounding membrane and have to be distinguished from a scar or small perforation ; if they are large, the drum appears wrinkled, and the rays of light reflected from their surface radiate towards the circumference.

Owing to retraction of the membrane, the processus brevis and posterior fold may stand out prominently ; the cone of light may be absent or, if present, is usually broken and in an abnormal position.

As a result of chronic tubal catarrh, exudation may exist within the tympanic cavity and the membrane is usually markedly retracted with a pinkish ring round its margins from the chronic congestion of the peripheral vessels. If the membrane is transparent, the long process of the incus and the tendon of the stapedius, and the recess of the fenestra rotunda may be seen. The thickened annulus tendinosus, being more resistant, stands out clearly in comparison with the retracted membrane. Such cases may possibly be confused with a large perforation.

In some cases, the result of a previous middle ear catarrh, the malleus alone may be adherent to the promontory, the rest of the drum being freely movable; in later stages, perhaps from over-politzerizing, the drum on each side of the malleus may have become so relaxed as to bulge out exceedingly on either side of the malleus on diminishing the air pressure in the external meatus. In the more chronic cases the tympanic membrane may be so adherent to the inner wall as to remain immovable and have the appearance of parchment.

Examination of the nose and naso-pharynx usually shows the presence of some chronic catarrhal condition.

Hearing tests.—In cases of uncomplicated middle ear disease, the high tuning forks are well heard, bone conduction is good, and Rinne's test is either partially or completely negative. In the later stages, if the internal ear becomes secondarily involved there may be gradual loss of high-pitched notes and diminution of bone conduction.

Treatment is directed towards removing any secretion from the tympanic cavity, and if possible restoring the patency of the Eustachian tube, and the functions of the membrane and ossicles. Unfortunately, in the majority of cases, the pathological changes which have already occurred prevent a complete restoration to the normal condition, and the surgeon's efforts are directed not so much in attempting a cure as to prevent progress of the disease. It must be acknowledged that in some cases local treatment to the ears themselves is useless, and may even do harm. It is of importance to recognize this fact. In such cases, however, much may be done to alleviate such distressing symptoms as tinnitus and vertigo, which may cause greater distress than the loss of hearing.

Treatment may be divided into : (1) Local treatment of the ears themselves ; (2) Treatment of the nose and naso-pharynx ; (3) General treatment to restore the bodily health or to alleviate the subjective symptoms.

Local treatment may be non-operative or operative.

Non-operative treatment.

(1) THROUGH THE EUSTACHIAN TUBE.—(*a*) **Inflation.** Inflation may be carried out either by Politzer's method or by the catheter. Before inflation the hearing should be tested and the tympanic membrane inspected to see if it is thickened, atrophied or retracted. At the first consultation, the catheter should be used, as with it a more certain diagnosis can be made of the condition of the Eustachian tube and tympanic cavity. The auscultation sounds heard may be (1) Rough, irregular, and somewhat distant, from general thickening of the mucous membrane and narrowing of the Eustachian tube ; or (2) at first distant, then becoming suddenly louder, especially during the act of swallowing, from the Eustachian tube suddenly becoming patent ; this is met with in cases of chronic tubal catarrh ; or (3) accompanied by coarse râles showing the presence of exudation within the tympanic cavity.

Result of Inflation.—(1) There may be no improvement in hearing if the membrane is firmly adherent to the inner wall of the tympanic cavity. (2) In a typical case of chronic middle ear catarrh with thickening of the membrane and narrowing of the Eustachian tube, improvement in hearing is seldom very great. The hearing should be tested immediately after inflation to see how great an improvement, if any, has taken place. (3) In cases of chronic tubal catarrh in which the membrane is much retracted and lies against, but is not adherent to, the inner wall of the middle ear, in spite of deafness having existed for a long time, there may be marked improvement in the hearing from the membrane being driven out from the inner wall.

The improvement obtained in the hearing from the first inflation is usually not permanent, diminution of hearing gradually taking place within a day or two, perhaps after a few hours; this is especially so when the membrane is relaxed and again falls back on to the inner wall of the tympanic cavity preventing normal movement of the stapes.

Even if no improvement in hearing is obtained, the act of inflation may relieve the feeling of oppression in the head and diminish the tinnitus. As a rule, if there is no improvement at all after the first inflation, the prospect of obtaining any benefit by this method will be very slight. It is unwise, however, to give a definite opinion after the first visit. *If there is no improvement after the third visit, inflation should not be further attempted.* If inflation does good it should be repeated twice a week so long as improvement takes place. Usually the greatest benefit is obtained at first, and then improvement becomes less, and finally the maximum of hearing is reached after which further inflation appears to be useless. It should then be stopped. In some cases instead of doing good inflation does harm by temporarily increasing the deafness or by setting up tinnitus; this more often occurs in mixed cases of chronic middle ear catarrh with otosclerosis or internal ear disease. It is an indication to stop inflation.

(*b*) **Instillation of medicated fluids or vapours through the Eustachian tube.** It is very questionable whether such instillations in themselves do much good; probably the benefit derived, if any, is due to the act of inflation of the air. (i.) *Vapours* may be introduced into the Eustachian tube by Politzer's method, or by the catheter; the latter is the more certain method. The vapours of volatile fluids are used, such as acetic ether, sulphuric ether, or chloroform. (*a*) If a Politzer's bag is used it is sufficient to insert the nozzle into the mouth of the bottle containing a small quantity of the medicament to be employed; the bag is then compressed. On allowing the bag to expand again it becomes filled with the vapour. Inflation is then carried out in the ordinary manner, when it is hoped that some of the vapour will enter the Eustachian tube. (*b*) If a catheter be used, a few drops of the above volatile substances or of the following mixture :—T^{c}. iodine, ♏v.; ethyl chloride, ʒi.; acetic ether, ʒi., are poured on to a little cotton wool, within a small globe, which is fitted to the tube of the air bag used in catheterization. On pressure of the bag the air is driven through the globe containing the cotton wool and thus becomes impregnated with the vapour.

(ii.) *Injections.* Like the vapours, the medicated fluids injected into the Eustachian tube are supposed to act on its mucous membrane. Many drugs are recommended, but the following are considered to be the most serviceable :—A solution consisting of sodium bi-carbonate, drachm ½; glycerine, drachm 1½; distilled water to the ounce, which is used in cases where there is a chronic thickening of the mucous membrane; a 10 per cent. watery solution of potassium iodide in cases of syphilitic origin; liquid vaseline, which in itself does not cause any reaction, or a 2 per cent. solution of pilocarpin when there is swelling of the Eustachian tube; or a 1–3 per cent. solution of chloral hydrate when tinnitus is very severe. Only sterilized solutions of these fluids must be used. A catheter is passed and air is gently inflated into the Eustachian tube to see that it is in the right position. The patient's head is then tilted over to the affected side. With a small Pravaz syringe, 5 or 6 drops of the solution are injected into the catheter and the fluid blown into the Eustachian tube by compressing the air bag. It is difficult to know how much value to attach to this method of treatment. In some cases there is no benefit; in others, if improvement takes place it may be due to the effect of the inflation rather than to the medicated vapour. The risk of injecting fluids is greater than using vapours, as there is always a certain amount of reaction. If too much fluid is injected, especially if it is not sterilized, there is danger of setting up an acute middle ear inflammation.

A more scientific method of introducing medicated fluids into the Eustachian tube is by means of compressed air (which is stored up in a cylinder) and a multi-nebulizer. A continuous current of medicated vapour can in this way be introduced into the Eustachian tube at any given pressure for as long a period as may be required. Through the action of the nebulizer the fluid is reduced to such a fine vapour that it can be safely used in more concentrated solutions. I have frequently found this method to be of greater benefit than the simple inflation of vapours, or the injection of fluids through the Eustachian catheter. For this purpose the following mixture may be used in cases of recent catarrh :—

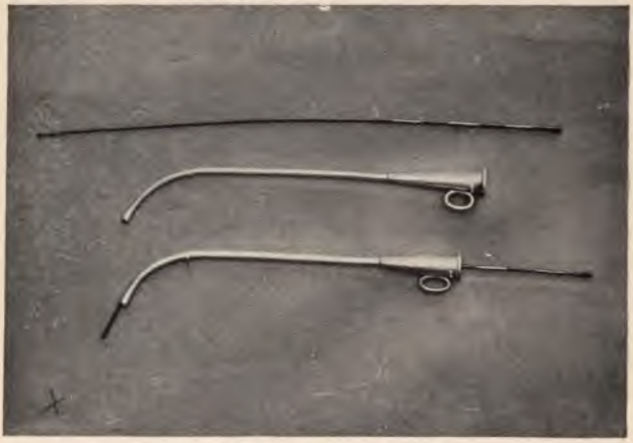
Menthol	gr. v.
Camphor	gr. iij.
Ol. Cassiæ	min. v.
Fluol ad.	℥i.

or

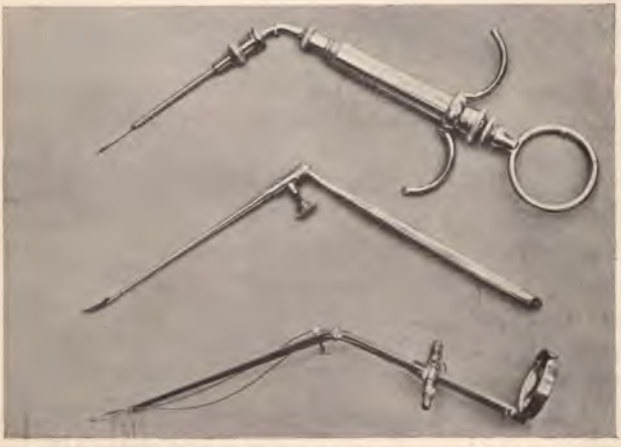
Iodine	gr. v.
Potass. Iodid.	gr. xxx.
Ol. Menth. Pip.	min. ij.
Glyc.	ʒij.
Aq. ad.	℥i.

in the more chronic cases with thickening of the mucous membrane ; or a solution of cocaine hydrochlor. grns. v, liquid extract of suprarenal and chloretone of each ½ ounce, in cases of acute congestion of the Eustachian tube, especially if there is tinnitus.

By whatever method these medicated fluids are introduced into the Eustachian tube, the process should not be repeated daily. According to Politzer the best method of procedure is to simply inflate on the first day, to instil or inject the medicated fluid or vapour on the second and do nothing on the third day ; this cycle should be repeated as long as improvement is obtained, provided the instillation or injection of fluid does not set up any reaction within the tympanic cavity. No hard



Eustachian Catheter and Bougie.



1. Syringe for Subcutaneous Injection. 2. Paracentesis Knife. 3. Wilde's Snare.

[*Plate XI.*

and fast rule can be laid down as to how long such treatment should be carried out in the hope of improvement.

(c) **The Eustachian bougie** is used for two reasons: (1) as a means of diagnosis to demonstrate the existence and position of a stricture; (2) therapeutically to dilate a stricture, or, if the bougie is medicated, to actually treat the mucous membrane of the Eustachian tube.

The bougie is used when inflation shows that the Eustachian tube is obstructed and when the improvement in hearing after inflation only lasts for a very short period. Bougies are made of various materials. For ordinary purposes the gum elastic is the best. Whalebone bougies are useful for dilating long-standing fibrous strictures, as the gum elastic, from being soft, tend to bend and not to pass through the stricture. Celluloid bougies are good but they may get brittle, and there is danger of the point snapping off. *Bougies should only be employed by experts.* They are about 7 inches in length, with a slightly bulbous point; in size they diminish downwards from No. 1 (English size urethral catheter). Five inches from the point of the bougie (that is the same length as the catheter), is a black band, a centimetre in length; a centimetre farther up the bougie is another back band; again after another intervening space of a centimetre is a third black band. The object of these marks is to let the surgeon know, on passing the bougie through the catheter into the Eustachian tube, at what distance its point is projecting beyond the point of the catheter. (See Plate XI.) Strictures of the Eustachian tube are usually situated at the Eustachian orifice if the result of a recent post-nasal catarrh, or at the isthmus in the more chronic conditions accompanied by general thickening of the mucous membrane of the middle ear.

Technique of Passing the Bougie.—The catheter is first introduced. By means of the auscultation tube and gentle inflation of air, it is made certain that the point of the catheter is in its correct position at the Eustachian orifice. The catheter is kept firmly fixed in position by means of the thumb and finger of the left hand. The bougie is then pushed into the catheter until the first mark is just reached; that is, until its tip reaches the point of the catheter. It is then very gently pushed forward, no force being used. If there is no pain, and no great resistance, it is pushed on until the beginning of the second black band is at a level with the outer extremity of the catheter, that is 2 centimetres. The bougie now projects 2 centimetres into the Eustachian tube, that is about the region of the isthmus. At this point some resistance may be met with as the bougie passes through the isthmus. After the isthmus is reached the bougie should not be pushed further in than another centimetre, or it may enter the tympanic cavity. On the first introduction of the bougie there is a subjective sensation of pain in the pharynx or throat; as soon as the bougie enters the Eustachian tube the pain is generally referred to the ear itself. On reaching the isthmus the bougie may be felt by the patient as if it were actually within the tympanic cavity, and its movement will be heard by the surgeon through the auscultation tube. The bougie should be left in situ for 5 to 10 minutes at a sitting. After removal of the bougie, the ear should again be gently inflated, when the air entry into the tympanic cavity will probably be found to be much more free. The passage of the bougie produces a certain amount of reaction ; it should not be passed oftener than once a week. The largest size bougie which can be passed without much resistance should be used. No force should ever be employed. At the second sitting if this bougie passes easily, a size larger may be attempted.

When the obstruction to the Eustachian tube is limited to its pharyngeal end and is chiefly due to a simple swelling of the mucous membrane, *medicated bougies* are of great service. They are made of catgut. A short time before using, their points are dipped into the astringent to be employed and are then allowed to dry. A solution of 10 per cent. silver nitrate is recommended for this purpose.

Difficulties of passing the bougie.—(1) The bougie may pass behind the lip of the Eustachian catheter and enter Rosenmüller's fossa ; this will probably produce retching and coughing, and a sensation of pricking in the throat.

(2) A stricture at the orifice of the Eustachian tube may be so great as to prevent the entry of the bougie.

Dangers.—The chief danger is using too much force and lacerating the mucous membrane with possible production of surgical emphysema. If much pain accompanies an attempt to pass the bougie, it should at once be withdrawn. If it is tinged with blood no further attempts should be made at this sitting, nor again for at least one week. The bougie may be pushed too far through the Eustachian catheter, and cause injury to the contents of the tympanic cavity. Only a bougie which is properly marked should be used, and care must be taken not to mistake the markings. The tip of the bougie may break off whilst in the Eustachian tube. This is an unfortunate disaster which is difficult to remedy. To avoid this calamity the bougie should be carefully examined before it is used.

Results.—If the obstruction is limited to the pharyngeal end and has not existed for a very long period, the result of treatment is sometimes excellent. When, however, there is a general thickening of the Eustachian tube, even if temporary improvement is obtained, there is a continual tendency for further stricture to take place, and the final result may become worse than the original condition.

(*d*) **Electrolysis.**—To overcome strictures of the Eustachian tube electrolysis has been recommended, especially by our American colleagues. Good results are said to have been obtained in some cases, but it is doubtful if they remain permanent

The bougie in this case consists of gold wire with an olive shaped tip. It is passed through the catheter up to the site of the stricture. Its outer end is attached to the negative pole of the battery whilst the positive contact electrode is held in the hand of the patient. The voltage of the battery should not be more than 20 volts ; a current of 1 milliampère is used which is steadily and slowly increased up to 3 or 4 milliampères. Within half a minute or so the bougie should pass through the stricture. The bougie should not be passed more frequently than once a week.

Although some authorities are in favour of the use of bougies and electrolysis for Eustachian tube obstruction, my own experience is that the treatment is unsatisfactory, and that the indications for their use are extremely limited.

(2) THROUGH THE EXTERNAL MEATUS.—In conjunction with inflation of the ear through the Eustachian tube, attempts may be made to break down or loosen adhesions within the tympanic cavity by passive movement of the tympanic membrane from without.

This treatment consists of vibratory massage and rarefaction of the air within the external meatus.

(*a*) **Massage.**—There are two methods of massage: (1) By means of the pneumatic speculum or pneumatic masseur and (2) By direct mobilization of the ossicles by Lucæ's probe.

(1) If *Siegle's speculum* is used, it is inserted into the external meatus and the ball alternately compressed and relaxed as rapidly as possible. The *pneumatic masseur* is of greater value than Siegle's speculum, in that the vibrations may be produced with varying and exceeding great rapidity. The pneumatic masseur may be driven by the hand or by the electromotor.

When using Siegle's speculum care should be taken that the massage is begun with the ball compressed so that the air in the external meatus is rarefied rather than condensed.

If a machine is used the stroke of the piston must not be more than a quarter of an inch, otherwise the alternating compression and rarefying of air within the external meatus may be too great and do harm. Each application should not last for more than half to one minute. If the treatment is of benefit and the patient intelligent he may be entrusted with a masseur to use at home, provided he is warned not to overdo the treatment and to stop it as soon as it fails to do good.

(2) *Direct mobilization of the ossicles* by means of *Lucae's probe.*—At the tip of the probe is a cup-like depression. In its handle is a spring to render its action resilient. Its application is often extremely painful. This may be mitigated by the previous instillation in the ear of a few drops of Grays' solution (10 per cent. solution of cocaine in equal parts of alcohol and aniline oil). The probe is applied to the processus brevis of the malleus; the vibrations are given by rapid movements of the hand from the wrist, the arm being kept fixed. This procedure, of course, should be done under reflected light. Its duration should not be longer than half to one minute and should not be repeated for at least a week.

(*b*) **Delstanche's Rarefacteur.**—This instrument was devised by Delstanche, and consists of a metal tube fitted with a piston. To its nozzle is attached some india-rubber tubing to whose other end is fixed an olive-shaped vulcanite tip, which will accurately fit into the external meatus. On pressing the piston the air is condensed within the external meatus. The piston is fitted with a spring so that when the pressure is relaxed it recoils to its extreme length and causes rarefaction of the air within the external meatus.

The rarefacteur can either be used as a masseur by making rapid movements of the piston to and fro, or, as its name implies, solely as a rarefacteur. For this purpose the piston is first pressed inwards before the rubber tubing is fixed into the external meatus. After this has been done the piston is relaxed, the pressure within the external meatus in this way being markedly diminished, and the instrument is then left in situ for as long a period as may be desired.

Indications for using the masseur, rarefacteur, and Lucae's probe.—(1) In cases of recent middle ear catarrh, to remove, after inflation, the stuffy feeling in the head or the tinnitus, which, although diminished, may still be present. (2) In the more chronic conditions of middle ear catarrh, massage in combination with inflation often seems beneficial in alleviating in some degree the oppression in the head and the tinnitus, probably by increasing the mobility of the ossicles and by altering the tension within the tympanic cavity and labyrinth. (3) Lucae's probe acting directly on the malleus is suitable for those cases where the malleus itself is adherent to the inner wall of the middle ear. (4) The rarefacteur is employed when the drum is greatly retracted and thickened, and temporary benefit is obtained by inflation; also, in some cases, apparently by diminishing the tension, it causes considerable diminution or even temporary cessation of the tinnitus. (5) After operations on the tympanic membrane such as tenotomy of the tendon of the tensor tympani, or after separating adhesions between the malleus and promontory or cutting through the posterior fold, the rarefacteur may afterwards be used to draw the membrane from the inner wall in the hope that the adhesions may be less liable to re-form.

Contra-indications for the use of the masseur and rarefacteur are (1) if the malleus is adherent to the promontory and the membrane is relaxed on each side; in such cases treatment will tend to increase the relaxation of the drum. (2) If tinnitus or vertigo are produced. (3) If earache is set up as a result of extreme congestion.

Operative treatment.

Various operations have been attempted in the hope of relieving the subjective symptoms, and to improve the hearing ; in the majority of cases, even if temporary benefit is obtained, the final result is unsatisfactory. This is not to be wondered at considering the smallness of the tympanic cavity and the tendency for the reforming of adhesions. *No operation should be performed unless it is certain that the internal ear is not also involved ;* that is, there must be no diminution for bone conduction nor for the hearing of high tuning forks. Gelle's test should be positive ; if negative it usually means that the stapes is fixed, but this is not reliable.

Under operative treatment may be mentioned : (1) **Artificial perforation of the drum.**—This is only justifiable if the tinnitus and vertigo are intense, and persist in spite of other treatment, in cases where the drum is very much thickened and the Eustachian tube is obstructed by a long-standing stricture. The object of the operation is to equalize the pressure within the tympanic cavity and external atmosphere, and thus relieve the increased tension within the middle ear and labyrinthine cavities. The artificial perforation may be performed with a knife or galvano-cautery, and should be made in the posterior quadrant.

If a paracentesis knife be used, a simple incision is not sufficient ; a small triangular flap of the membrane must be excised. The galvano-cautery is preferable to the knife, as the perforation does not tend to close so readily. Paracentesis is done in the ordinary manner (*see* p. 133). If the cautery be used, it is applied cold; when in contact with the drum the circuit is closed, the cautery becoming red hot. Care must be taken not to push the cautery very far through the membrane, or the inner wall may be burned, possibly resulting in adhesions. This operation should be done under a general anaesthetic (gas and oxygen is usually sufficient). The ear should afterwards be protected by a small strip of gauze. After the acute inflammatory reaction has subsided, gentle inflation should be practised daily in the hope of preventing closure of the perforation. Even if there be an immediate improvement in hearing and diminution of the subjective symptoms, a relapse nearly always takes place from reclosing of the aperture. Linear incisions radiating from the malleus towards the circumference of the drum are sometimes advocated in cases where the drum is very relaxed.

(2) **Cutting through adhesions.**—This operation is sometimes advised if there is extreme deafness of the middle ear, in the hope that by freeing the membrane and malleus from the inner wall of the middle ear the functions of the ossicles may in a great measure be restored and the hearing improved. An operation should only be attempted if the adhesions are very limited.

With a paracentesis knife the membrane is cut through round the adhesions; a small sharp knife, whose blade is bent at right angles to its shaft, is then inserted between the inner wall of the tympanic cavity and the membrane and cuts through the adhesions. After the operation the rarefacteur should be used to try and draw out the membrane. After two days, inflation and pneumatic massage should be practised with a view to preventing the reforming of adhesions; they almost invariably recur.

(3) **Tenotomy of the Tensor Tympani** is sometimes practised in cases in which the tympanic membrane has been retracted for a considerable period, owing to obstruction of the Eustachian tube, and remains retracted even after inflation, although not adherent to the inner wall of the middle ear, owing to contraction of the tensor tympani. The operation consists in cutting through the tympanic membrane, as high up as possible, close behind the malleus. Schwartze's tenotomy knife is then inserted through the incision and gently turned forward; as it is twisted round, it should cut through the tendon. As in the former cases, massage and inflation should afterwards be practised.

(4) **Incision of the Posterior Fold.**—This is also practised in cases of marked retraction of the drum, and may be done in combination with tenotomy of the tensor tympani muscle. A small vertical incision is made in the posterior fold, at its most prominent part, with a fine tenotomy knife.

(5) **Ossiculectomy** (removal of the malleus and incus) may be advised if the deafness has existed for a considerable period, but is no longer progressive, and if it is due to the malleus being bound down by adhesions to the promontory. If the membrane is tightly bound down so that there is no movement in the posterior upper quadrant in the region of the incudo-stapedial joint, it is probable that adhesions

also fix the stapes to the margins of the fenestra ovalis, and in such cases removal of the malleus and incus would be ineffectual. This operation should never be insisted on, and the possibility of failure should be carefully explained to the patient. It should only be attempted if there is deafness on both sides. After removal of the malleus and incus, the hearing power is, on an average, reduced to 12 feet for ordinary conversation; if the hearing power of the patient is better than this, operation is contra-indicated. (For description of operation, *see* p. 176.)

In certain cases, if the patient's life has become almost unbearable from the occurrence of severe and repeated attacks of vertigo, ossiculectomy is justifiable provided other means have failed to cure these attacks, and if it can be fairly assumed from marked retraction of the membrane, and from Gelle's test being positive, that the attacks of vertigo are due to increased tension within the labyrinth from pressure inwards of the stapes.

(6) **Removal of the Stapes** is an operation which is not advised.

(7) The **mastoid operation** has also been advocated, not only to improve the hearing, but in order to relieve the subjective symptoms; this procedure is not justifiable.

Treatment of the nose and naso-pharynx.—As in all cases of middle ear disease, any condition producing a post-nasal catarrh must be remedied (*see* Chapter XV).

General treatment.—Alcohol and smoking must be limited. In plethoric patients the general congestion of the mucous membrane may be relieved by occasionally ordering a mercury pill at night, followed by a saline purgative in the morning; if, in such cases, there is a sudden increase of tinnitus or attacks of vertigo, in addition to purging and light diet, cold compresses may be applied to the head in combination with hot foot baths. If there is any suspicion of syphilis, a course of treatment of potassium iodide is indicated; in cases of anaemia, some mild preparation of iron. When the deafness or other subjective symptoms repeatedly get worse during damp weather, especially if associated with general catarrh of the upper respiratory tract, the patient, if possible, should reside in a dry climate during the winter months. The higher altitudes of Switzerland or the milder climate of Egypt or Orotava may be recommended; the Riviera, although a popular winter resort, is not so suitable, owing to its sudden variations of temperature and the cold winds.

In the later stages of this disease tinnitus or vertigo may be the principal symptoms requiring treatment. The treatment of these distressing affections is one of the most difficult problems the aural surgeon has yet to solve.

Tinnitus.—In addition to local treatment, potassium or ammonium bromides may be given in 10 grain doses three times a day, combined with two or three minims of liquor arsenicalis. In the gouty, or where there is evidence of arterio-sclerosis, red meat diet and alcohol should be strictly limited; free action of the bowels may be obtained by taking Carlsbad salts or Apenta water early in the morning before breakfast; in addition, lithia or Vichy water is often of service. To the ammonium bromide mixture may be added potassium iodide and sodium bicarbonate, 5 grains each. If there is anaemia, iodides may be given combined with iron in the form of syrup of iodide of iron, one drachm three times a day. If a prolonged course of iodides is indicated, syrup of hydriodic acid (a teaspoonful three times a day) may be substituted for the ordinary potassium iodide preparation. If the internal ear is also involved, strychnine should be given three times a day, beginning in doses of $\frac{1}{60}$th grain, rapidly increasing it to $\frac{1}{30}$th grain. For the sake of convenience this may be prescribed in tablet form—potassium iodide 5 grains, strychnine $\frac{1}{60}$th grain; one or two tablets to be taken twice or three times a day according to the individual case. The tablets should be dissolved in a little water, and then taken in a large glass of milk or water. If the tinnitus is of a pulsating character, small doses of tincture of digitalis is often of service, even although there are no signs of a cardiac affection. If the tinnitus is of sudden and intense onset, a rest cure may be advised, especially if the patient is in bad health, or suffering from mental worry or of a neurotic temperament; in addition a blister may be applied over the mastoid process, to act as a counter-irritant.

As a last resource *galvanism* may be tried. The positive electrode is placed in front of the ear and the negative at the nape of the neck. The current is gradually increased from zero up to 3 milliampères; above this point vertigo may be produced. If benefit is going to be derived there should be diminution or cessation of the tinnitus so long as the current is passing through. The constant current should only be employed for a few minutes, and before the electrodes are removed the current should be gradually decreased again to zero in order to prevent shock. In other cases high frequency currents have been advocated. Patients who obtain relief by these methods are usually of a very neurotic type.

Vertigo.—If no obvious local cause can be found within the ear to account for this condition, it may be due to vascular changes causing increased tension within the labyrinth. In such cases the administration of alkalies combined with small doses of iodides seem to be of service. If the vertigo is severe, the patient should be kept in bed; aperients should be given, and the diet light. As in the case of tinnitus, it may be necessary at first to give large doses of bromides. If tinnitus accompanies the vertigo, quinine may be given, remembering that in some cases it may increase instead of diminishing the tinnitus. The quinine is best given in combination with dilute hydrobromic acid as follows :

Quin. sulph.	gr. ij.
Ac. hydrobrom. dil.	ʒi.
Spir. chloroformi	min. x.
Aq. menth. pip.	℥i.

Two tablespoonfuls every six hours.

If the quinine has no bad effect, the dose should be rapidly increased up to 5 grains three times a day. As soon as the tinnitus and vertigo cease, the dose should be gradually diminished and stopped.

Operative treatment has been suggested when neither local treatment nor drugs have any effect. This is referred to again in diseases of the internal ear, but it may here be stated that with regard to tinnitus no operative measures have proved successful, although in one or two cases the attacks of vertigo have been diminished or cured by partial removal of the semicircular canals.

Prognosis of Chronic Middle Ear Catarrh.—The prognosis is relatively more favourable if the onset of the deafness has been slow, if the tinnitus is slight and intermittent, if the bone conduction is good and high tuning forks are well heard. Prognosis is favourable in proportion to the improvement in hearing and relief of subjective symptoms after inflation and other local treatment. Conversely, prognosis is bad if the deafness is rapidly progressive, the tinnitus marked and continuous, the bone conduction diminished and the high tuning forks badly heard, and further if improvement after inflation and other local treatment is slight or of a temporary nature, or worse still, if there is no benefit. Any general constitutional disturbance such as gout, anaemia or debility renders the prognosis less favourable than if the patient is otherwise in a good state of health. The effect of drugs and climate should also be taken into consideration. Complete recovery of hearing cannot be expected. It is usually necessary for treatment to be resumed from time to time at intervals of some months, but *each course of treatment should be limited and stopped as soon as the maximum amount of improvement has been obtained.* In chronic tubal catarrh the result of treatment by bougies may be very good if the stricture is chiefly due to simple swelling; when, however, it is due to thickening of the connective tissue, the results are usually disappointing. Operative treatment, as a rule, is unsatisfactory, especially if the catarrhal condition is progressive; a good result can only be expected if the adhesions are the result of a past catarrh, if they are limited and if the deafness is due to the malleus being immovable. If the middle ear only is affected, the deafness will not become complete. If one ear is affected, the other ear usually also becomes involved at some later date, and then rapidly and often to a greater extent than the originally affected ear.

OTOSCLEROSIS

This is the term given to a chronic progressive deafness due to pathological changes in the capsule of the labyrinth, resulting in the complete fixation of the stapes to the margins of the fenestra ovalis and usually in involvement of the labyrinth itself. Clinically it is diagnosed from "chronic middle ear catarrh with adhesions" by the absence of the ordinary symptoms of catarrh.

Pathological changes.—In the earlier stages there is congestion of the muco-periosteum of the inner wall of the tympanic cavity; later, production of spongy bone (osteoporosis) takes place, chiefly round the margins of the fenestra ovalis, eventually causing fixation of the stapes by bony ankylosis. Patches of this spongy bone may be found in the vestibule, cochlea, or semicircular canals, and they can be shown by microscopic examination to be sharply defined from the normal bone. Together with osteo-porosis there may be sclerosis of the bone, so that in the late stages bony masses may partially or completely fill up the fenestrae and the labyrinth itself.

The Aetiology is uncertain. It usually begins between the ages of 20 and 30, but may occur in younger individuals, when it may possibly be due to inherited syphilis. It is most frequently found in young anaemic women, in whom pregnancy and especially parturition tend to hasten the course of the disease. Heredity plays an important part. Some cases are associated with an atrophic condition of the mucous membrane of the nose and naso-pharynx, the Eustachian tubes being widely patent and the external meatus dry and glazed. It is also frequently associated with gout.

Subjective symptoms.—The earliest symptom may be *tinnitus*. Tinnitus in anaemic women, especially after parturition or if there is a history of early progressive deafness in the family, which does not disappear after a course of general treatment, should be looked on with suspicion as an early symptom of otosclerosis. At first the tinnitus is intermittent, but it may become continuous and so intense as to be unbearable. After many years, when deafness has become complete, the tinnitus may cease; on the other hand, it may continue throughout life and is frequently far more distressing than the loss of hearing. In chronic middle ear catarrh the tinnitus is usually referred to the ears but in otosclerosis to the head itself.

The deafness is progressive, and differs from that of chronic catarrh with adhesions in not being so influenced by other conditions, such as dampness or change of climate, and in its progress being a more even one. Its course may be slow or rapid. Sometimes the deafness remains stationary for a long period and then rapidly gets worse; at first it may be unilateral, but afterwards the other ear also becomes affected. Frequently the first indication of deafness is an inability to hear general conversation, especially if carried on in low tones; the voices are heard, but the words cannot be clearly picked out.

In otosclerosis *paracusis Willisii* is usually well marked. If only the middle ear is affected deafness will not be complete and the voice will be well heard through a speaking trumpet, but when the internal ear gets involved complete deafness may eventually occur. The deafness is generally worse after mental or bodily fatigue. In the later stages there may be attacks of vertigo.

Objective signs.—There are usually no changes in the tympanic membrane itself, but if the membrane is thin, the hyperaemic wall of the promontory may be seen to shine through as a pinkish coloured crescent, which is almost pathognomonic of this condition. The external meatus is often glazed and dry, the mucous membrane of the nose and naso-pharynx pale and thin, and the Eustachian tube widely patent. If the internal ear is not affected, the bone conduction will be good, Rinne's and Gelle's tests negative, and the high tuning forks will still be well heard; as the internal ear becomes involved, there will be loss of hearing power for the high notes, and Rinne's test may become positive, though greatly shortened.

The **Diagnosis** is made, on the one hand, from chronic middle ear catarrh with adhesions by the normal appearance of the drum and the absence of the usual symptoms of catarrh, and on the other hand from internal ear deafness by means of tuning fork tests; mixed forms, however, may be met with in which otosclerosis and middle ear catarrh with adhesions co-exist. In other cases internal ear deafness may develop simultaneously or secondary to the middle ear affection.

Treatment.—*Local treatment is useless; in fact, may do harm.* Treatment must therefore be directed to the maintaining of the general bodily health in as good a condition as possible. Mental worry and overstrain should be avoided. Women should be warned of the marked deleterious effect of pregnancy and parturition.

Many drugs have been given in the hope of arresting the progress of this disease. Reliance is now chiefly placed on two:—iodides and phosphorus. It is possible that the good effects of the iodides in some cases may be due to the disease being syphilitic in origin.

The following mixture may be given three times a day.

Potass. Iodid.	gr. x.
Spt. Ammon. Aromat.	ʒss.
Tinct. Nucis Vomicae	♏vii.
Spt. Chloroformi	♏v.
Aq. Cinnamomi ad.	℥i.

Phosphorus is recommended by Siebenmann. It may be given in globules of oil of phosphorus, each globule containing $\frac{1}{60}$th grain of phosphorus; or as a syrup of phosphorus, each drachm of which also contains a $\frac{1}{60}$th grain. If the internal ear is beginning to be affected, an excellent tonic is one combining phosphorus with strychnine, namely syrup of glycero-phosphates, which contains $\frac{1}{60}$th grain strychnine in a drachm.

The treatment of tinnitus and vertigo have already been mentioned in the previous chapter.

The **Prognosis** is bad. Much depends on maintaining the general health and avoiding mental and physical strain in every form. Anaemia should be specially guarded against. As the disease progresses neuralgia of the head is apt to occur and the neuralgic tendency tends to become more marked. The younger the patient, as a rule, the more rapid is the course of the disease.

CHAPTER VI

ACUTE INFLAMMATION OF THE MIDDLE EAR

ALTHOUGH pathologically it is often difficult to distinguish between a catarrh and inflammation of the middle ear, yet clinically they represent two distinct types.

In catarrh the process is generally a gradual one, running an indefinite course without any very marked symptoms, tending to resist treatment and, if temporarily cured, to relapse.

In *inflammation*, on the other hand, the onset is sudden, the course of the disease rapid and acute, but in favourable circumstances usually ending in complete recovery and not tending to relapse.

In catarrh there is no danger to life ; in inflammation, if the affection is virulent, the inflammatory process may spread to the deeper structures of the middle ear, to the mastoid, or the intracranial cavity, and eventually have a fatal termination.

For the purpose of clinical description, acute inflammation of the middle ear is sub-divided into (1) **Acute Otitis Media ;** that is cases of acute inflammation in which perforation of the tympanic membrane has not taken place ; and (2) **Acute Middle Ear Suppuration,** in which perforation has taken place.

Pathologically these conditions cannot be separated, the acute otitis media being merely a milder infection which may or may not end in acute middle ear suppuration.

In acute inflammation, the mucous membrane rapidly becomes swollen and turgid with an early production of a muco-purulent exudation into the tissues of the mucous membrane and into the tympanic cavity ; usually the mucous membrane of the antrum and mastoid cells is also involved. The exudation consists of fluid containing mucus and pus cells and corpuscles. At first the fluid is thin, later it becomes thicker and more purulent. If resolution now takes place, the mucous membrane may again become normal ; if, however, the process continues, the deeper structures become affected.

ACUTE OTITIS MEDIA

Aetiology.—Acute inflammation of the middle ear occurs at all ages, but more frequently in the young.

The following are the more frequent causes : (1) An acute nasal or post-nasal catarrh, especially if associated with adenoids or nasal obstruction. (2) The entrance of fluid into the Eustachian tube from bathing or douching of the nose. (3) Specific fevers, such as scarlet fever, measles, small-pox, typhoid and diphtheria. (4) Direct infection through the Eustachian tube from operative procedures in the post-nasal space, such as the removal of adenoids, from plugging the posterior nares to arrest epistaxis, or from the employment of a septic Eustachian catheter or bougie. (5) Infection from without ; as in involvement of the middle ear in a fracture through the middle fossa of the skull. (6) As a complication of influenza, pneumonia or whooping cough.

The direct cause of the inflammation is microbic infection. Before perforation of the membrane a pure culture can usually be obtained; after perforation has taken place the infection often becomes a mixed one and many varieties of micro-organisms may be present. In the pure cultures pneumococci and streptococci are frequently found; staphylococci are usually present in combination with other micro-organisms after perforation of the membrane. Many other micro-organisms have been found, such as the bacillus of typhoid, diphtheria, tubercle, or influenza, the gonococcus, and the meningococcus intracellularis of Weichselbaum.

Symptoms.—The chief symptoms are earache accompanied by deafness and pyrexia. The onset is sudden, being ushered in by sharp, paroxysmal, or pulsating pains in the ear which may radiate up the side of the head and down towards the neck and teeth. The pain is worse at night, often preventing sleep. At the height of the inflammation it may be unbearable, being especially aggravated by coughing, crying or sneezing. The temperature may reach 100° or 101° Fah., and in children considerably higher. The younger the patient, the greater the constitutional disturbance. In adults at first there may be only a feeling of fullness in the ear which soon becomes throbbing in character and may be accompanied by tinnitus, and occasionally by attacks of vertigo. Frequently, there is tenderness on pressure over the *tip* of the mastoid, especially if influenzal in origin; if the external meatus is also inflamed there may be pain on movement of the auricle. One ear only may be affected, but when occurring as the result of specific fevers usually both are involved. The deafness is rapid in its onset and well marked. Generally the whole tract of the middle ear is affected, but occasionally the inflammation is limited to the attic.

Objective signs.—The tympanic membrane rapidly becomes congested. In the early stages there is injection of the vessels along the malleus and at the circumference of the membrane. As the congestion increases, tiny vessels are seen radiating over its surface (Plate XII, 1); they rapidly increase in number until the membrane becomes uniformly red with obliteration of the landmarks giving it the appearance of a highly-glazed copper surface, but the short process of the malleus may still be seen as a yellowish white point. With this there is considerable bulging of the tympanic membrane, chiefly in its upper posterior quadrant, from accumulation of secretion within the tympanic cavity. The congestion may extend along the upper posterior wall of the auditory canal, making it difficult to say where the meatus ends and the membrane begins. In influenza, ecchymoses or bullae containing sanious fluid may be seen on the tympanic membrane or external meatus. (Plate XII, 2.) If recovery is going to take place without perforation, the congestion subsides, the angry red colour gradually disappearing, the membrane becoming of a duller hue and lustreless, and rough from desquamation of the epithelium, until, eventually, after two or three weeks, it again resumes its normal appearance.

If, on the other hand, perforation is imminent, the membrane will appear of a purplish red or yellow colour and bulge prominently, sometimes as a nipple-shaped projection, at the point where the perforation is going to take place. Rarely, the acute inflammation is limited to the attic showing marked congestion of Shrapnell's membrane, which sometimes bulges outwards overhanging the processus brevis, the rest of the membrane remaining comparatively normal in appearance; in these cases headaches, a feeling of fullness in the head, tinnitus or attacks of vertigo are sometimes intense and seem out of all proportion to the objective signs; this is especially so in influenza, in which the subjective symptoms may last for a considerable period after the acute inflammation has subsided.

The *course of the disease is rapid;* the inflammation reaches its maximum from within a few hours to eight days, usually on the third or fourth day, and then gradually subsides or passes on to acute suppuration with perforation of the membrane. When perforation takes place, the intense pain disappears and the patient at once has a feeling of great relief.

Tests of hearing usually show the signs of middle ear deafness. Sometimes, however, from transient changes in the labyrinth, there may be marked loss of bone conduction and hearing power for the high tuning forks. As recovery takes place, the bone conduction and hearing power for the high tones return.

In cases of acute inflammation limited to the attic, the deafness may only be slight.

Complications of acute otitis media are rare.

(1) *Facial paralysis* may occur during the course of the attack, but usually passes off after a few weeks (*see* p. 235).

(2) *Acute mastoid disease*, without perforation of the membrane, is very uncommon.

(3) *Meningitis*, also, is a rare complication, usually occurring in infants, but also may occur in adults as the result of influenza.

The **Diagnosis** is made from the history and the appearance of the membrane. It has, however, to be distinguished from (1) a large perforation of the membrane with congestion of the inner wall, and (2) from an aural polypus (*see* p. 161). In children, acute inflammation of the middle ear may give rise to symptoms of meningitis.

Prognosis.—If occurring in healthy individuals, there is usually complete recovery to normal hearing within four to six weeks. The inflammation, however, may not completely subside, but pass into a condition of chronic middle ear catarrh with exudation or adhesions. After influenza, tinnitus and neuralgic pains (otalgia) may continue for a considerable period. The presence of post-nasal catarrh or adenoids tend to cause relapses or, eventually, middle ear suppuration.

If occurring in the course of specific fevers, the prognosis is not so good, owing to the liability of subsequent middle ear suppuration, or of complete deafness from simultaneous involvement of the internal ear, which, however, is rare.

Treatment.—The patient must be kept in bed and only liquid diet given until the acute stage has passed off. If there is much pain and pyrexia, a Dover's powder at night followed by a smart saline purge in the morning often is of great benefit. Severe headache may be relieved by phenacetin, or phenacetin combined with aspirin. In addition, a simple diaphoretic mixture may be prescribed until the temperature becomes normal.

Local treatment to the ear is at first palliative; the immediate indication is to relieve the pain. For this purpose the following drops are recommended to be instilled frequently into the ear :—

Cocaine	gr. ij.
Morphia	gr. i.
Carbolic acid	gr. iij.
Sweet Almond oil	ʒi.

Great comfort may be obtained by covering the side of the head with a thick pad of hot cotton wool on which some tincture of opium or chloroform has been sprinkled. Occasionally warm compresses of lint covered with oil-silk (changed every two or three hours) are preferred. *The ear should not be syringed*, nor are *hot* fomentations advised, as they tend to increase the congestion. If the symptoms do not abate within twenty-four hours, or if the progress of the inflammation is very rapid and the pain severe, leeches may be applied in front and behind the ear to relieve the congestion; this is sometimes of benefit, especially in children.

After the acute stage has passed away, local treatment should be gradually stopped, and for some days the ear should be protected by means of a pad of cotton wool. In order to promote absorption of the exudate, *inflation* by Politzer's method is advised, *but must not be begun until all the acute symptoms have completely disappeared*. The inflation must be very gentle; production of pain means that it has been too forcible or has been begun too soon. As the exudation gets absorbed there is improvement in hearing; at first this may only last a very short time. Inflation should be repeated according to the rules already laid down (p. 90). In adults, if only one ear is affected, catheterization is preferable to Politzer's method.

In addition to local treatment of the ear, attention should be directed to the nose and throat. Any existing nasal and post-nasal catarrh should be treated by means of sprays or inhalations (*see* p. 301); in the case of acute tonsilitis, a tablet of formamint may be sucked every hour or so, and a mixture of salicylate of sodium and potassium bicarbonate given in doses suitable to the age of the patient. *During the acute stage, a nasal douche should not be used*, and no operative measures on the nose or naso-pharynx should be attempted, but, to diminish the risk of relapses, any nasal obstruction should be remedied, and adenoids and enlarged tonsils removed after the acute attack has completely subsided.

If, in spite of treatment, the inflammatory process continues, **paracentesis** (incision) of the tympanic membrane may be necessary. *It is indicated* :—(1) If there is increasing congestion and bulging of the membrane, especially in the upper posterior quadrant, accompanied by pyrexia and pain. (2) If there is obvious presence of pus shown by a circumscribed angry red or yellow protuberance on the tympanic membrane. (3) If there are any cerebral symptoms, such as drowsiness, vomiting, vertigo or convulsions. (4) If there is tenderness over the mastoid process. (5) If the paroxysms of pain are so acute as to prevent sleep.

Palliative treatment should, if possible, be attempted for forty-eight hours before resorting to paracentesis; but each case must be judged on its own merits.

Paracentesis should be done early (1) in infants and (2) in specific fevers, as in the latter there is frequently rapid destruction of the membrane.

In all cases of doubt it is wiser to perform a paracentesis early than late.

Technique of Paracentesis.—The auricle and surrounding parts are surgically cleansed; the auditory canal is gently syringed with a 1 in 20 solution of carbolic acid or a 1 in 2,000 solution of biniodide of mercury, and then lightly packed with a strip of gauze soaked in 1 in 500 of the latter solution. If the pain is too great to allow of this procedure, some drops of a 10 per cent. solution of carbolic acid in glycerine may be instilled into the ear.

This preliminary toilet should be done, if possible, at least half an hour before the operation is performed. These preparations though comparatively trivial are of great importance, as, provided no secondary infection takes place through the external meatus, the results of paracentesis are usually most favourable, the acute symptoms disappearing and the perforation healing within two or three weeks, sometimes much earlier.

A general anaesthetic should be given as the pain of paracentesis is exceedingly great and but slightly diminished by local anaesthetics.

If the patient refuses a general anaesthetic, an attempt may be made to locally anaesthetize the tympanic membrane. A few drops of *Gray's solution* may be instilled into the ear 15 minutes before the operation.

Cocaine	gr. xij.
Aniline oil	ʒi.
Absolute alcohol	ʒi.

A free incision is made through the membrane with a paracentesis knife which is shaped like a tiny bistoury set at an angle to its handle. (Plate XI.) Excepting in those rare cases where the bulging is most marked in the antero-inferior quadrant, the incision should be made through the posterior part of the membrane, beginning low down, and extending upwards so as to incise the membrane midway between the malleus and the circumference right up to its margin, at the same time cutting through the soft tissues at the upper posterior wall of the external meatus, close to the membrane, if they also are congested. In this way free drainage is given to the contents of the tympanic cavity, attic and antrum, and owing to the incision being carried upwards into the external meatus much relief is obtained from depletion of the congested vessels.

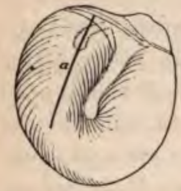


FIG. 5. — Diagram to show *Paracentesis* of the Tympanic Membrane. *a*. Line of incision.

If the inflammation is limited to the attic it is only necessary to incise Shrapnell's membrane.

After the first rush of discharge and blood has been mopped away, a small drain of sterilized gauze is inserted into the auditory canal, the ear being then protected by a sterilized pad of gauze or wool.

The gauze drain and dressing is changed once, twice, or three times a day according to the abundance of the discharge. If possible, this should be done by a competent person to insure it being carried out under proper aseptic conditions. Too much importance cannot be insisted on in keeping the ear clean. (For further treatment, *see* p. 145.)

Mistakes to be Avoided in Doing Paracentesis.—(1) The usual fault is to mistake the congested posterior wall of the external meatus for the membrane. (2) The incision must not be made in too timid a manner, especially if the patient is not under a general anaesthetic; otherwise, as soon as the prick of the paracentesis knife is felt the patient may jerk his head away and it will probably be impossible to incise the membrane. (3) *The incision must be free.* A bare puncture of the membrane is of little value, as in most cases the wound will heal too soon. (4) Care must be taken not to incise too deeply, for fear of injuring the inner wall of the middle ear.

OTITIS MEDIA IN INFANTS.—This deserves special mention owing to its importance.

At birth the tympanic cavity is lined by thickened mucous membrane of an embryonic character and may contain a gelatinous exudation which soon becomes absorbed.

The Eustachian tube is relatively wider and more patent than in the adult. The petro-squamous suture permits of free communication between the vessels and lymphatics of the tympanic cavity and middle fossa of the cranial cavity.

In infants under three years of age post-mortem examinations in a series of 100 cases have shown the presence of otitis media in 90 per cent. of cases where it was not suspected in life (Ponfick); it is not yet certain whether this condition is always due to acute inflammation of the middle ear or to degenerative changes after birth. *In young children earache is always a symptom of middle ear catarrh or inflammation,* however mild it may be, and its frequency is probably due to infection through the Eustachian tube in attempts at coughing up secretion in bronchial and pulmonary affections, or perhaps to the entrance of fluid during the act of vomiting.

Symptoms.—They may vary. There may be repeated and mild attacks of earache. If the child is ill from some general cause, such as pulmonary or gastro-intestinal affections, the ear symptoms may pass unnoticed. Usually there is pyrexia, which may be extreme. In tiny infants, who cannot speak, there is great restlessness, continual crying, rolling of the head from side to side and putting up of the hands to the head. In addition there is pain on touching the ear and the child cannot lie on the affected side. *In severe cases there may be convulsions, retraction of the head, vomiting, and other symptoms simulating acute meningitis.* On the other hand the symptoms may be those of a gastro-intestinal character accompanied by emaciation and diarrhoea. In children a little older, if the attack is not very severe, there are intervals when the child seems quite well and plays about quite happily until suddenly there is another attack of intense earache. As soon as perforation takes place there is relief, and the acute symptoms disappear. In infants it is possible for pus to exist within the tympanic cavity without perforation occurring. Usually the membrane is red and bulging. In some cases, however, in spite of the most severe head symptoms, the drum may appear white and lustreless, or its almost normal condition may seem to negative middle ear disease. In young children disease of the gastro-intestinal and respiratory tract is often associated with otitis media which may probably stand in a causative relation to these affections. In infants and young children the ears should be regularly examined in all cases of pyrexia which cannot be definitely diagnosed, especially if head symptoms are present simulating meningitis.

Treatment.—This is the same as for adults, but a paracentesis should be done early and is at once imperative if there are any head symptoms. I have in several instances performed paracentesis in infants in whom the symptoms simulated a well-marked meningitis and the tympanic membrane showed no signs of middle ear inflammation, and yet, as a result of paracentesis, pus escaped and the symptoms of meningitis at once disappeared.

CHAPTER VII

ACUTE MIDDLE EAR SUPPURATION

Aetiology.—The causes are the same as those producing acute otitis media (p. 126). In addition may be mentioned (1) Direct wounds of the tympanic membrane, produced by the insertion or during the extraction of a foreign body. (2) A paracentesis performed as a preliminary step in intra-tympanic operations, in which asepsis has not been obtained. (3) General infection through the blood as in meningitis and pyaemia.

Acute inflammation arising in the course of specific fevers, influenza, and septic conditions of the tonsils and naso-pharynx (especially after operative procedures), is extremely liable to end in middle ear suppuration.

Rarely, middle ear suppuration may occur without perforation of the tympanic membrane. (1) In young children in whom the pus may escape by the Eustachian tube, and (2) in adults, in whom, instead of a perforation in the membrane, there may be a fistula through the attic or antrum, which affords an exit for the pus into the external meatus.

Symptoms.—The symptoms are similar to those of acute otitis media, but as a rule they are more acute. The pain in the ear is intense and continuous, and often radiates over the whole side of the head. It may be so excruciating as to render the patient almost delirious. There is usually tenderness about the ear and over the *tip* of the mastoid, and in some cases over the body of the mastoid process. From pressure of the exudation and congestion of the labyrinthine vessels there may be marked tinnitus and sometimes attacks of vertigo. There is a marked diminution of hearing. As a rule, only one side is affected, but if due to specific fevers both sides may be involved. Perforation of the tympanic membrane usually takes place on the third or fourth day, but it may occur earlier, especially in specific fevers and influenza, or, on the other hand, may be delayed until the second week. When the membrane ruptures there is a feeling of great relief accompanied by a thin, sanious or muco-purulent discharge, and there is rapid abatement of the fever and head symptoms. If the pain and pyrexia continue, it means that there is insufficient drainage. *If, however, the purulent discharge is free, the continuance of the pain and pyrexia is a grave symptom,* as it usually means that the acute inflammatory process has extended to the mastoid cells or the intracranial cavity. The discharge gradually becomes thicker and more purulent, until, by the third or fourth day after perforation, it is of a creamy consistence, and of a yellowish green colour. Profuse discharge usually lasts for at least two weeks and then gradually diminishes in quantity, becoming thinner and clearer until it ceases between the fourth and sixth week.

In order to obtain a view of the tympanic membrane it is first necessary to cleanse the external meatus, which is usually filled with a muco-purulent discharge, sometimes so profuse that it literally drips from the ear. From extension of the inflammation to the auditory canal, there may be considerable swelling of its walls and desquamation of its epithelium.

Method of cleansing the ear.—There are two methods. (1) The *dry method*, in which the secretion is mopped out by means of small pledgets of wool until a clear view can be obtained. (Plate III.) This is preferable to syringing, as it diminishes the risk of further infecting the tympanic cavity by driving the fluid into its recesses; also by applying a mop carefully to the surface of the drum and then quickly withdrawing it, it is usually possible to see the exact spot from which the pus exudes; that is, the site of the perforation. A speculum and reflected light must be used.

(2) *Syringing.*—This is only necessary if the secretion is very profuse, or if the auditory canal cannot be cleansed by the above method.

Technique of syringing.—The patient should be sitting down, as syringing may cause giddiness. *The fluid should be at a temperature of* 100° *Fah.* The head is inclined over to the affected side, and the surgeon pulls the auricle upwards and backwards so as to straighten the auditory canal. The syringe is inserted a short distance within the meatus and applied to the upper posterior wall, so that the stream of water will run along the roof of the canal to the drum and then return along the floor, thus washing out the contents. No force must be used. Before syringing, in order to see that the syringe is full, and to prevent discomfort to the patient from the admixture of air bubbles with the lotion, the syringe should be held with the point up and the piston pressed until the lotion comes out of it. The best syringe is one with a metal plunger, as it can be easily sterilized. After syringing, the ear should again be carefully inspected and the auditory canal thoroughly dried.

If the inspissated pus or epithelial débris cannot be removed by syringing, ear baths of warm hydrogen peroxide (vols. 10), should be given, and the ear again syringed out after 15 minutes.

A diagnosis should never be made until all the secretion has been carefully removed from the auditory canal, as otherwise it may not be possible to accurately make out the true condition of the drum and surrounding parts.

Objective signs.—The drum is carefully inspected after wiping away the secretion, which may be seen to exude from the perforation in pulsating drops; this pulsation is characteristic, and is transmitted from the congested vessels of the mucous membrane of the tympanic cavity to the fluid, causing change of its level and so of the light reflected from its surface.

Just after the perforation has taken place the tympanic membrane is found to be extremely congested and on its surface may be seen ecchymoses, macerated epithelium and débris, so that its margins may with difficulty be differentiated from the inflamed walls of the external meatus. Sometimes a perforation cannot be seen, but it can usually be inferred from the persistent recurrence of a drop of secretion after wiping it away.

The size and position of the perforation varies.—(1) It is usually small, sometimes not bigger than a pin point, is round or oval in shape, and situated between the malleus and circumference of the drum, in its lower half. If of large size, it is generally the result of specific fevers. (Plate XII, 4 and 6.)

(2) Sometimes a pin-point perforation may be seen at the apex of a nipple-like projection of the membrane, especially in the posterior superior quadrant. In such cases, owing to insufficient drainage there is often delay in healing, and if neglected there is a tendency for acute inflammation of the mastoid process to occur later.

(3) Rarely, the perforation may be limited to Shrapnell's membrane, the result of acute inflammation of the attic.

If the perforation is sufficiently large, the inner wall of the tympanic cavity may be seen of a reddish colour, from congestion of its mucous membrane, but a good view is not generally obtained owing to the abundance of the discharge.

As the inflammation subsides and the discharge diminishes, the membrane gradually resumes its normal condition with the reappearance of its various landmarks. In the healing of a perforation the middle layer (*substantia propria*) of the membrane is not regenerated, and in consequence of this the scar is thinner and more freely movable than the rest of the membrane. For some little time after cicatrization has taken place, vessels may be seen radiating from the scar to the periphery of the membrane.

The Diagnosis is based on the history and inspection of the drum. A perforation is usually easily recognized by seeing the pus exude from it, especially if there is pulsation.

A tiny perforation may exist and yet not be seen if it lies in the antero-inferior quadrant, owing to the formation of the external meatus.

A perforation is diagnosed.—(1) By inspection. (2) By using Siegle's speculum; the external meatus is carefully cleansed and Siegle's speculum is inserted into the external meatus and the air exhausted; this causes some secretion to be sucked out of the tympanic cavity through the perforation. (3) By gentle inflation; (*a*) Some secretion mixed with bubbles may be seen lying on the surface of the membrane. (*b*) On listening with the diagnostic tube during the act of inflation, hissing and crackling sounds will be heard as the exudation and air are forced out of the perforation.

Acute middle ear suppuration has to be diagnosed from—

(1) An acute exacerbation occurring in a chronic middle ear suppuration. This is of importance with regard to the prognosis (*see* next chapter).

(2) Meningitis—usually in children.

(3) Tuberculous disease (*see* p. 289).

(4) Acute inflammation of the external meatus. In adults, if a view of the membrane can be obtained, the diagnosis is made by inspection, by Siegle's speculum, and, if necessary, by inflation; if, however, owing to inflammatory swelling of the walls of the auditory canal a view of the drum cannot be obtained, diagnosis may be difficult. The secretion from the external meatus is usually scanty and contains epithelial débris; if from the tympanic cavity, it is more profuse and may contain mucous threads. In infants the diagnosis is often extremely difficult.

Prognosis.—In the great majority of cases a simple middle ear suppuration ends in complete recovery with normal hearing and restoration of the membrane to its normal condition, but frequently traces of past inflammation may be seen on the membrane in the shape of scars, opacities or calcareous deposits. (Plate XII, 7.)

After the suppuration has ceased, hearing, however, may remain imperfect. (1) From adhesions having taken place between the membrane, the ossicles and the inner wall of the tympanic cavity. (2) From persistence of the perforation.

The prognosis is not so favourable when there is a general catarrh of the upper respiratory tract, or if the suppuration is due to specific fevers. There is a special tendency for delay in healing when the perforation is situated high up, especially if situated at the tip of a nipple-like projection of the tympanic membrane. Many other conditions which tend to delay recovery will be discussed in the next chapter.

During the course of acute middle ear suppuration *the following complications may occur* :—

(1) Inflammatory enlargement of the upper cervical glands; this is not uncommon in children, and has to be distinguished from tuberculous disease.

(2) The pus may track down into the naso-pharynx along the wall of the Eustachian tube, simulating a retro-pharyngeal abscess.

(3) Facial paralysis.

(4) Acute inflammation of the mastoid process.

(5) Involvement of the labyrinth.

(6) Intracranial complications.

These will be discussed later under their various headings.

Treatment is directed towards relief of the pain, free drainage and asepsis. The continuance of pain or pyrexia may be due to insufficient drainage, owing to the perforation being too small. If the membrane is still found to be bulging, it should be freely incised. If, in spite of further incision, pyrexia and pain persist, it may become necessary to perform the simple mastoid operation (*see* p. 201).

Usually, after the perforation has taken place the pain disappears and the temperature becomes normal again within two or three days. The patient should be kept in bed, given a light diet and freely purged.

Local treatment of the ear is begun by carefully cleansing it of all secretion. If the purulent discharge is profuse and thick it may be necessary to gently syringe out the ear with a warm solution of boric acid or potassium permanganate. If inspissated pus or macerated epithelium cannot be removed, an ear bath of a warm solution of hydrogen peroxide (vols. 10) should be given and left in the ear for at least 15 minutes, the fluid being then gently syringed out. The ear is now carefully dried with small pledgets of sterilized wool. After this thorough cleansing and drying of the ear, it is sufficient to insert a narrow strip of gauze into the auditory canal to act as a drain. This should be removed as soon as it becomes saturated with secretion. Before a fresh piece is inserted the ear should be cleansed by carefully mopping it out with pledgets of wool moistened with a solution of 1 in 3,000 of biniodide of mercury.

For the first few days this may be necessary every two or three hours ; later, as the discharge diminishes the strip may only have to be changed daily. The ear should be protected by a pad of gauze and wool. If there is much neuralgia, hot dry compresses, on which a little chloroform or laudanum has been sprinkled, may be more comforting. This method of treatment is known as the *dry* treatment, and should be adopted whenever possible.

In the *wet method* the secretion is removed by syringing out the ear with a mild antiseptic lotion as frequently as may be necessary to cleanse the external meatus. This method is not advised, because it is possible that some of the fluid may be driven into the tympanic cavity and further infect it with other germs, *thus setting up a mixed infection, which is one of the principal factors in producing a chronic middle ear suppuration.* This method, however, in spite of these objections, is frequently the only one which it is possible for the patient to carry out.

Insufflation of powders, such as boric acid or iodoform, *is contra-indicated* in that they may prevent the outflow of the discharge ; they should only be prescribed in the more chronic conditions where there is very little discharge and the perforation is a large one. If the discharge is very thick and tenacious, its removal may be aided by suction through the external meatus by means of Siegle's speculum. If the perforation tends to close and symptoms of retention of pus (headache and earache) recur, the membrane must again be freely incised. If the perforation is at the apex of a nipple-shaped projection the projecting part should be snared off.

The discharge may produce diffuse inflammation, furunculosis or eczema of the external meatus.

As in the case of otitis media, *special attention must be paid to the nose and throat*, and any condition predisposing to the continuance of middle ear inflammation should be remedied or removed; the removal of adenoids or tonsils must not be performed until the acute stage of middle ear suppuration has passed away.

After the purulent discharge has ceased, and the perforation in the tympanic membrane has healed, in order to prevent adhesions between the membrane, ossicles, and the inner wall of the tympanic cavity, inflation should be gently practised in the manner already described (*see* p. 90). There is still considerable difference of opinion as to when inflation should be begun. Politzer says that as in middle ear inflammation or suppuration the lining mucous membrane of the whole of the middle ear tract is similarly affected, there can be no danger in inflation of the ear within a few days after the onset, provided that in so doing no pain is produced. Other authorities do not agree with this statement, and oppose inflation in the early stages as likely to produce infection of the mastoid cells. It has already been stated that a probe passed along the Eustachian tube would directly cross the attic and enter the antrum, also that it is possible to have an acute inflammation localized to the attic region; therefore it seems probable that a forcible inflation through the Eustachian tube might drive septic secretion back into the antrum and in this way infect the mastoid cells. For this reason I, personally, prefer *not to inflate the ears until the acute inflammation within the tympanic cavity has subsided.*

CHAPTER VIII

CHRONIC MIDDLE EAR SUPPURATION

In the earlier stages, when only the mucous membrane is affected, the chief causes which may retard recovery and favour transition to the chronic condition are :—(1) Neglect of treatment, especially with regard to asepsis, so that the tympanic cavity becomes secondarily infected with other micro-organisms and (2) Insufficient drainage.

Amongst the general causes tending to prolong the disease are unhealthy surroundings, general poorness of health, anaemia, rickets, syphilis and tuberculosis; or local conditions such as persistent post-nasal catarrh, or the presence of adenoids; extensive destruction of the tympanic membrane or contents of the tympanic cavity, from whatever cause, will also tend to prevent recovery. In the later stages the local conditions within the middle ear itself which prevent cure are retention of the purulent secretion within the tympanic cavity, antrum and mastoid cells; the formation of granulations and polypi; caries of the ossicles or extension of the disease to the bony walls of the middle ear and mastoid process. Chronic middle ear suppuration is more commonly found amongst the poor than the well-to-do owing to their difficulty in carrying out proper treatment.

Although occurring more frequently in adults than in children its origin often dates from early childhood.

Pathology.—The pathological changes vary very greatly. As a result of the chronic inflammation there is considerable thickening of the mucous membrane from an extensive round-celled infiltration and increased vascularity of its tissues. In the milder forms only the mucous membrane may be affected, and that to a varying extent. In some parts it is swollen and succulent, in others it is denuded of its epithelium with the production of erosions and ulceration of its surface, whilst again from local proliferation of the tissues may arise granulations and polypi. In more severe cases, the deeper structures may become affected with involvement of the bone, which may be carious or, in rare conditions, necrosed in parts. As the inflammation subsides and recovery takes place, the production of new connective tissue tends to bind together the ossicles, and if the inflamed or ulcerated surface of the drum and inner wall of the tympanic cavity come into contact they may become firmly and permanently adherent to one another. If the destructive process is great, the ligaments may be destroyed, the ossicles exfoliated, and the surrounding bony parts involved. As a rule the whole of the tympanic cavity is affected, but occasionally the disease is limited to the attic. Extension of the disease may spread to the mastoid process, labyrinth or even to the intracranial cavity itself.

Subjective symptoms.—After the acute stage of middle ear suppuration has subsided the patient may become so accustomed to the deafness, especially if only one ear is affected, and may be so little inconvenienced by the discharge, which is frequently slight and intermittent, as to neglect further treatment, and it is chiefly due to these reasons that the majority of cases pass into the chronic stage. If the perforation is large and the drainage free, the condition may exist for years without the occurrence of any urgent symptoms. From time to time, however, owing to retention of the purulent discharge, especially in cases of attic suppuration, there may be attacks of headache, a feeling of heaviness or fullness in the head, or pain radiating from the ear, and it is frequently noticed by the patient that these symptoms occur after a temporary cessation of the discharge, relief being obtained as soon as the purulent discharge recurs. At other times the patient may become alarmed from the appearance of blood in the discharge or from the onset of tinnitus or vertigo; or the continuance of the discharge, especially if of an offensive character, may eventually cause such annoyance as to make him seek medical advice. In the lower classes especially, unless there is actual pain, treatment is often grossly neglected and even the protrusion of a polypus from the external meatus may hardly arouse the suspicion that the ear is seriously affected.

In other cases again the first apparent symptom may be facial paralysis (*see* p. 234) or the aural affection may have been entirely forgotten until the patient is seized with a sudden illness which may not at first be referred to the ear, but on examination is found to be due to some intracranial complication or perhaps septic infection of the lateral sinus; conditions which unfortunately are often only seen when it is too late for treatment to save life.

From the continued irritation due to the purulent discharge there may be recurrent attacks of diffuse inflammation, eczema or furunculosis of the external ear.

It is of the utmost importance to determine the exact condition of the tympanic membrane and cavity and of the surrounding bony parts, as on this depends subsequent treatment; in order to do this the auditory canal must first be carefully cleansed.

The discharge varies; it may be thin, viscid or thick, mucoïd or purulent, odourless or offensive; it may contain epithelial débris, cholesterine crystals, blood, gritty particles of bone, and always micro-organisms. It may be profuse but is usually slight in amount, or there may be no apparent discharge but instead crusts may be found lining the auditory canal or hiding the perforation and tympanic membrane from view, or again offensive caseating masses of epithelium and inspissated pus may fill up the tympanic cavity or protrude from the region of the attic or antrum.

From the character of the discharge a certain amount of information may be obtained. Mucous secretion can only come from the tympanic cavity, but pus containing epithelial débris and no mucous threads may possibly only come from the external meatus. Clumps of epithelial débris with cholesterine crystals occur in the more chronic conditions of middle ear suppuration, especially in the condition known as cholesteatoma. The presence of gritty particles of bone is in itself evidence of bone disease. A sanious discharge is suggestive of the presence of granulations and polypi, or, as a rare possibility, of malignant disease. An offensive discharge does not necessarily mean bone disease, but a continuance of this discharge in spite of treatment is suggestive of this condition. If the middle ear suppuration is tuberculous in origin, the discharge is usually slight, thin, often sanious and of a peculiar offensive smell, and very irritating to the surrounding tissues.

Objective signs.—On examination of the ear through the aural speculum the condition seen is one of infinite variety, depending on the size and position of the perforation and on the pathological changes which have occurred in the tympanic membrane, tympanic cavity, and its bony walls. The *perforation* may vary from the size of a pinpoint to complete destruction of the membrane. When the bony walls are not affected, the rim of the tympanic membrane usually remains owing to the resistance of the thickened annulus tendinosus and of the anterior and posterior folds. In some cases, however, generally the result of scarlet fever, there may be complete destruction of the membrane with exfoliation of the ossicles.

The position of the perforation is of diagnostic importance.

1. A perforation situated in the antero-inferior quadrant is usually associated with catarrh of the Eustachian tube or bone disease around its tympanic orifice.

2. If the perforation involves the lower part of the tympanic membrane, the cause of the delay in healing may be an accumulation of the purulent secretion owing to inefficient drainage in that part of the tympanic cavity which lies below the level of the tympanic membrane, the so-called "cellar" of the tympanic cavity.

3. If in the first instance there has been a rapid and extensive destruction of the drum, a large kidney-shaped perforation may be seen; immediate healing is unable to take place owing to the size of the perforation, and recovery afterwards tends to be indefinitely delayed from repeated infection of the mucous membrane from without. In these cases the malleus is often retracted and adherent to the promontory. (Plate XII.)

4. A perforation in Shrapnell's membrane signifies disease of the attic with or without involvement of the ossicles. If situated in its anterior part, it may be due to local disease of the head of the malleus.

5. A perforation situated in the *upper posterior* quadrant is usually associated with disease of the ossicles, especially the incus, and of the bony margins of the aditus, antrum or mastoid cells. (Fig. 6.)

Except in tuberculous disease, when there may be multiple perforations, usually only a single perforation exists. Sometimes, however, a perforation may be seen in the tympanic membrane proper as well as in Shrapnell's membrane.

Diagnosis of a perforation.—A perforation may have to be diagnosed from a scar or an atrophic patch. If very large the exposed inner wall of the tympanic cavity may be mistaken for a polypus or bulging congested membrane.

1. A *perforation* is diagnosed by inspection; a break in the continuity of the tympanic membrane is seen, and if the perforation is large a view is obtained of the inner wall of the tympanic cavity. On using Siegle's speculum there is no movement over the site of the perforation and if there is any secretion it may be sucked

out mixed with bubbles of air. On inflation the characteristic perforation sound is heard except in those rare cases where scar tissue closes the opening to the Eustachian tube.

2. In a *scar* there is no break in the continuity of the membrane, but it is sharply defined from the rest of the drum and its surface is usually darker and somewhat depressed. With a Siegle's speculum, if it is non-adherent, it is more freely movable than the surrounding membrane, and if the air in the external meatus is rarefied the scar is seen to bulge outwards. On inflation a blowing sound may be heard, quite different to what is heard when a perforation is present.

3. *An atrophic patch* shades off into the surrounding membrane. If large it often has a wrinkled appearance, and the light is reflected from its surface in bright lines radiating towards the periphery of the drum. Like a scar it is more movable than the normal membrane.

For diagnosis between perforation and a *polypus* or *bulging membrane*, *see* p. 161.

It is important to distinguish a chronic perforation from a recent one; this is sometimes difficult, especially if there are acute symptoms accompanied by profuse discharge the result of an acute exacerbation of the chronic condition.

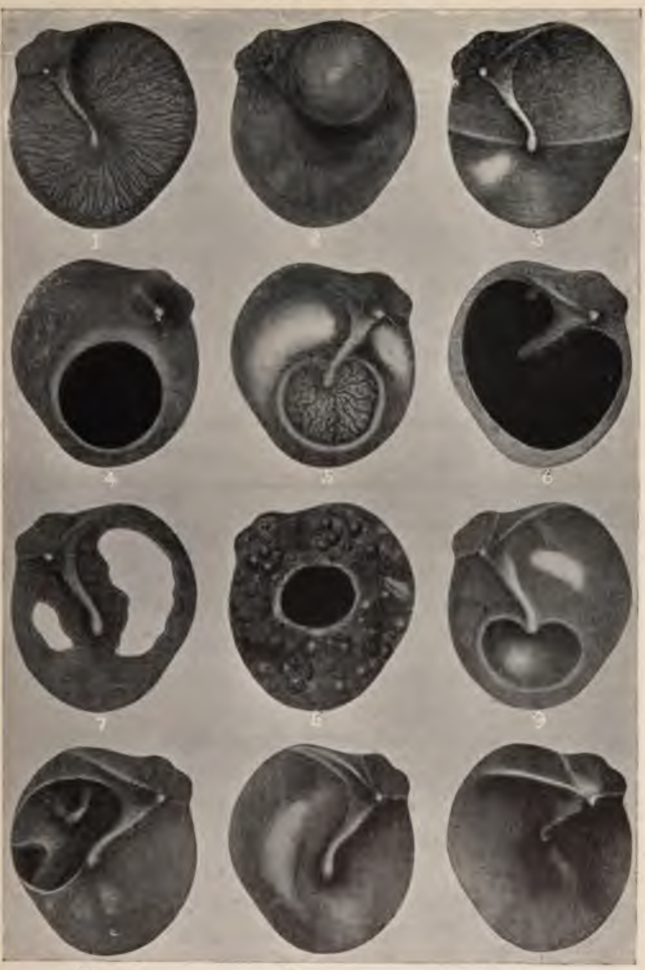
In a *recent perforation* the margins are thin with clear cut edges; in a *chronic perforation* the margins are often thick and may be bordered with tiny granulations, and if the membrane is retracted the edges may become adherent in parts to the inner wall of the tympanic cavity forming pockets in which secretion may collect. When the perforation is large it is sometimes difficult to say where the margins of the perforation end and the inner surface of the tympanic cavity begins.

Changes in the tympanic membrane.—The surface of the membrane is usually much thickened from desquamation of the epithelium, and is often of a greyish colour. On it may be seen chalky deposits, atrophic patches, scars, or granulations. If the perforation be small it may appear as a dark spot ; if large, a view is obtained of the inner wall of the tympanic cavity. (Plate XII.)

Changes in the tympanic cavity.—Its appearance varies according to the condition of the lining membrane. If there is much congestion with swelling of the mucous membrane, it may have the appearance of a smooth or slightly irregular red glistening surface ; if the inflammation has to a large extent subsided, the various anatomical points may be made out, such as the promontory, the long process of the incus, the incudo-stapedial joint, and the recess of the fenestra rotunda ; and over the surface of the promontory branches of the tympanic artery may be seen running upwards in a vertical direction.

After cessation of the discharge the mucous membrane of the inner wall may resume its normal appearance, or from ingrowth of the epithelium it may appear as a white glistening surface ; or from desquamation of its epithelial lining, clumps of epithelial débris may be found. On the other hand, if the inflammatory process continues, the inner wall may appear irregular with localized thickening of the congested mucous membrane

PATHOLOGICAL CONDITIONS OF THE TYMPANIC MEMBRANE.
(From Politzer's "Wandtafeln des Gehörorganes." Wilhelm Braumüller, Vienna. By permission).



1. Vascular injection of the tympanic membrane (acute otitis media).
2. Bulla in upper posterior quadrant.
3. Serous exudation in lower part of tympanic cavity.
. Perforation.
. Perforation with injection of vessels over the promontory.
Large perforation. The malleus lying in contact with the inner wall of the tympanic cavity.
Calcareous deposits.
8. Perforation. Surface of the membrane covered with granulations.
9. Kidney-shaped indrawn scar.
10. Perforation showing long process of incus, the incudo-stapedial joint, and the fenestra rotunda.
11. Thickening of membrane in its posterior part.
12. Retracted membrane showing foreshortening of malleus with marked projection of the processus brevis and of the anterior and posterior folds.

[Plate XII.

and be partially or completely covered with granulations.

Attic suppuration and caries of the ossicles.—Although it is comparatively rare to see an acute suppuration limited to the attic, in a chronic suppuration it is by no means uncommon. A perforation of Shrapnell's membrane, especially if the drum appears normal, may be easily overlooked. To obtain a view of the attic region, the patient's head, during examination, must be well inclined towards the opposite side. Sometimes, owing to crusts of inspissated pus covering Shrapnell's membrane, the perforation cannot be seen until the crusts are removed. Usually the perforation is single; it may, however, be double, one being in front and the other behind the malleus. The adjacent bone may be involved with or without the production of a fistula. From the perforation may protrude granulations, polypi, or epithelial débris. Examination with a probe will confirm whether there is carious disease of the ossicles, of the surrounding walls, or both. Carious bone, however, may be present without a probe being able to detect it. *The position of the perforation is of importance.* If situated in front of the malleus, it is often associated with disease of the malleus alone; if behind the malleus, then probably both the malleus and incus are affected; but if it extends still farther back,

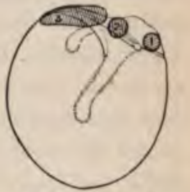


FIG. 6.—To show sites of perforation in Attic Suppuration and Caries of the Ossicles.

1. Perforation in front of malleus = disease of malleus.
2. Perforation behind malleus = disease of malleus and incus.
3. Perforation of posterior attic region and upper posterior part of membrane = disease of attic and possibly of the mastoid.

involving the upper posterior quadrant of the drum, it suggests disease of the incus together with the bony margins of the aditus and antrum, and perhaps also of the mastoid process. Disease of the ossicles may occur at a very early stage, especially as a result of specific fevers, or it may occur as a gradual process long after the onset of the suppuration. The incus, from its anatomical position and from its poor blood supply compared to the other ossicles, is generally first affected. The stapes rarely so. In over 100 cases in which middle ear suppuration had existed for two years, the ossicles were found diseased in 95 per cent. of the cases (Grunert). In a few cases the malleus remained normal, but in practically every case the incus was affected and in a fair proportion of cases it had disappeared. This fact is of importance in considering the question of treatment.

Disease of the bony walls.—Any part of the tympanic cavity may be affected, but the most usual situations are the attic and the bony margins of the aditus, from which may spring granulations or polypi. Bone disease may also involve the floor or promontory of the tympanic cavity, or the region of the Eustachian tube. Caries of the promontory is suspicious of tuberculous disease. Sometimes a fistula may be found leading through the superior wall of the auditory canal into the attic or through the posterior wall into the antrum or mastoid cells. Granulations at the mouth of a fistula situated in the posterior wall of the auditory canal may have to be diagnosed from furuncles. As the result of extensive disease the outer wall of the attic may have disappeared exposing the head of the malleus and the body of the incus, or an actual view of the antrum may be obtained from gradual absorption of the outer wall of the aditus. Bone disease may be inferred if granulations and polypi are not amenable to treatment and repeatedly recur after removal. With a probe the rough carious bone may sometimes be felt.

The *probe* is of malleable silver with a blunt point. It should never be poked into the ear in a haphazard fashion, but the surgeon should see what he is doing by using a speculum and reflected light. The end of the probe is bent according to the part to be examined; upwards for the attic, backwards for the aditus, and downwards when probing the floor. The probe is also used as a means of diagnosis for determining the origin of a polypus or the site of a fistula. (Plate XIII.)

Rarely, necrosis may occur and portions of the tympanic ring or of the promontory, or even the whole of the cochlea itself, may be found lying loose within the tympanic cavity or in the midst of granulations.

Granulations and polypi may be the result of simple inflammatory infection of the mucous membrane or underlying bone disease.

Granulations may completely cover the surface of the tympanic cavity or may sprout in small bunches from varying parts of its surface. They may have their origin in the region of the Eustachian orifice, the floor or promontory of the tympanic cavity, or protrude from the attic or region of the aditus.

Polypi may be single or multiple. They practically always have their origin from the tympanic cavity, but may grow from the tympanic membrane itself. Rarely, they appear to have their origin from the auditory canal, but in the majority of these cases the polypus is found to arise from the attic or antrum and to protrude into the auditory canal through a fistula of its upper or posterior wall. Polypi vary in consistence from extreme softness to a hardness simulating a fibroma, depending on the proportion of the round or spindle-shaped cells which may be present. Occasionally they may contain cysts, the result of degenerative changes. Their surface may be smooth or lobulated and covered with epithelium, which may show all the transient changes from simple ciliated epithelium to that of pavement epithelium.

Polypi and granulations of the ear contain more than 78 per cent. of granulation tissue and are consequently not tumours, but inflammatory tissue formation, which may become fibromatous but not fibromata.[1]

They may attain a large size, even protruding from the external meatus.

An aural polypus may in itself cause no symptoms excepting, perhaps, occasionally giving rise to hæmorrhage from the meatus. If, however, it is sufficiently large to obstruct the outflow of the secretion, symptoms of retention of pus may occur. On examination the polypus may be seen protruding into the auditory canal, preventing a view of the tympanic cavity.

It varies from a red to a greyish-white colour; its surface may be smooth and glistening or rough and nodulated. If small, it may be seen to grow from the inner or upper walls of the tympanic cavity or to press out through a perforation of the tympanic membrane; if large, its origin cannot be seen, but may be felt by a probe. *A polypus is not a disease* per se, *but merely a symptom of a disease.*

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[1] Bruhl: *Archives of Otology*, vol. 30.

A polypus has to be *diagnosed* from a congested bulging membrane, a large perforation where the inner wall of the tympanic cavity is smooth and red, and from an exostosis.

(*a*) With a *polypus* a probe can be passed round its circumference; it is movable and its nearness to the entrance of the external meatus should prevent it being mistaken from a bulging membrane or the inner wall of the tympanic cavity.

(*b*) With *a red and bulging membrane* there is usually the accompanying symptoms of an acute middle ear inflammation; vessels may be seen radiating over its surface, and the processus brevis or some other portion of the malleus can usually be recognized. Touching with a probe proves its structure to be membranous; with a Siegle's speculum, to and fro movements of its surface are seen.

(*c*) *The inner wall of the tympanic cavity* can only be confused with a polypus when there has been complete destruction of the membrane and exfoliation of the ossicles; as a rule, no matter how large the perforation may be, a remnant of the tympanic membrane and the malleus remain; touching with a probe shows the structure to be of bony hardness; inflation of the middle ear gives rise to the characteristic perforation sound.

(*d*) *An exostosis* is diagnosed from the probe being unable to pass completely round it, showing its origin from the bony meatus, and from its bony hardness.

Cholesteatomatous formation.—During the course of a chronic middle ear suppuration, epithelial débris or caseating particles of offensive odour may be found in the secretion or within the tympanic cavity, or protruding from a perforation of Shrapnell's membrane or through a fistula leading into the attic, or antrum. This condition is due to an accumulation of epithelium from excessive desquamation of the lining membrane. Originally a cholesteatoma was described by Virchow as a primary tumour of the temporal bone.

There are many theories with regard to cholesteatoma of the ear, but the obvious cause seems to be an ingrowth of the epithelium from the margins of the perforation which gradually spreads into the neighbouring cavities of the attic or antrum. Some other factor, however, must be present, as the excessive desquamation of the lining epithelium does not occur in every case. Presumably the exciting cause of the increased proliferation of the lining membrane is a chronic inflammation of the underlying bone. A cholesteatoma usually consists of a definite greyish white capsule (its epithelial lining membrane), containing a pultaceous mass of epithelial débris, cholesterine crystals, and bacteria. Cases are reported of cholesteatoma consisting of concentric stratified lamellae arranged in successive layers like the sections of an onion. This condition, however, I have never seen. In support of the view that this so-called growth is merely the result of an extension of the epithelium from the margins of the perforation is the fact that it almost invariably occurs in cases of chronic suppuration of the attic, or if there is perforation of the upper posterior quadrant of the membrane; that is in conditions in which the epithelium of the outer layer of the membrane can grow in and cover the neighbouring cavities. This condition is almost unknown when the perforation is situated in the central portions of the membrane. The cavity produced by a cholesteatomatous formation may become very large and, from absorption of the bone, the dura mater or lateral sinus may be exposed, or a fistula may extend into the external semicircular canal, or a large portion of the posterior wall of the auditory canal may gradually be absorbed and show a cavity not unlike the result of a complete mastoid operation, lined with a glistening white membrane. There may be no symptoms until, perhaps from moisture getting into the ear or from some infection from without, the epithelial masses may swell and give rise to symptoms of pressure, such as headache, vomiting or attacks of vertigo, or the first symptoms may be those of some intracranial complication.

Characteristic of a cholesteatoma is the offensiveness of the epithelial débris, the presence of cholesterine crystals, and the protusion of epithelial flakes from the attic or region of the antrum, which in spite of repeated removal tend to recur.

Impairment of hearing.—When the perforation is small, or if limited to Shrapnell's membrane, the hearing is often very good, but as a rule it is temporarily diminished if there is any acute exacerbation of the disease with increased secretion. On the other hand, the hearing power is sometimes greater, if there is a certain amount of discharge and appears to get worse when the discharge ceases; the secretion in these cases apparently in some way favours conduction of the vibrations of sound. The average amount of hearing in cases of extensive destruction of the membrane, provided there is no internal ear disease, no filling up of the tympanic cavity with granulation, and polypi, and no fixation of the stapes to the margins of the fenestra ovalis, is about 12 ft. for ordinary conversation and 6 to 8 ft. for whispering. In many cases the hearing is very much better and even whispering may be heard 20 ft. off. If, during the process of recovery, scar tissue binds down the tympanic membrane to the inner wall and the stapes become fixed by adhesions to the margins of the fenestra ovalis, the deafness may become very marked. In other cases, owing to involvement of the internal ear either at the onset of the disease as from scarlet fever, measles or enteric fever, or later on from gradual involvement of the inner ear as a sequela of middle ear suppuration, deafness may become absolute.

The hearing tests, therefore, may give results characteristic of a mild or severe form of middle ear deafness, or of a middle-ear combined with an internal-ear deafness, or of a complete internal ear deafness.

Treatment.—The routine treatment of a chronic middle ear suppuration, like all routine treatment, must necessarily in many cases be wrong, whether it is confined to constant syringing or to the ultra-surgical procedure of performing the complete mastoid operation whenever otorrhoea has existed for a few months. Between these extremes much can be done.

In suppurative disease of the middle ear there is not only impairment of the hearing power, but also danger to life itself, and although the primary object of treatment is to cure the patient of the disease, yet at the same time efforts should be made to preserve and, if possible, to restore the hearing power.

The principles of treatment consist in endeavouring to obtain free drainage of the purulent secretion, in keeping the parts aseptic, and in removing any actual or predisposing cause of the disease, if possible by conservative means, but if not, then eventually by operation. As in all cases of middle ear disease a thorough examination of the nose and post-nasal space must be made and, if necessary, any pathological condition must be treated (*see* Chapter XV). Although in many cases the continuance of a chronic middle ear suppuration is due to disease of the mastoid process, treatment of this condition will be considered later when discussing the various affections of the mastoid process. Treatment will here be limited to disease of the tympanic cavity itself. It may be divided into conservative and operative.

The conservative measures consist in syringing, the puffing in of powders, the instillation of drops, and the use of cauterizing agents.

Syringing should not be employed as a matter of routine, but usually in combination with other methods. The lotion with which the ear is syringed should be at a temperature of 100° Fah. Forcible syringing may cause giddiness or even symptoms of collapse. After syringing it is very important to thoroughly dry the ear.

Powders must only be used if the perforation is large, and if there is no stenosis of the external meatus. Only a small quantity of the finely divided powder should be puffed in by means of an insufflator, otherwise there is danger of obstructing the outflow of the discharge. Patients should be specially warned not to fill up their ears with powders.

Instillation of drops consists in the pouring in of a few drops of concentrated solutions of aseptic or astringent fluids into the ear after it has been carefully cleansed and dried.

Cauterizing agents are used for the purpose of destroying granulations or polypi. The actual galvano-cautery may be used, or a small bead of chromic acid or silver nitrate fused on to a probe, or a tiny mop of cotton wool soaked with a saturated solution of trichloracetic acid. The ear is first cleansed and dried, and rendered insensitive by the application of a few drops of a 10 per cent. cocaine solution, and again carefully dried before the cauterizing agent is applied. Care must be taken to only touch the affected part, and not the surrounding tissues. Trichloracetic acid is safer than chromic acid in that its action is more limited, but chromic acid is more powerful. After cauterizing, the ear should be lightly plugged with a strip of gauze.

Operative treatment consists in curetting away granulations, removal of polypi by the snare, and, in cases of attic suppuration, of removal of part of the membrane with the malleus and incus, with perhaps, also, the outer wall of the attic.

The treatment of the ear varies according to the condition found.

1. *The perforation is large.*—In such cases there is often a history of attacks of a muco-purulent discharge from the ear, the result of bathing or a cold in the head. Provided there is no sign of bone disease and the mucous membrane alone appears affected, the probable cause for delay in healing is repeated infection of the ear from without, either through the external meatus or

from the naso-pharynx through the Eustachian tube.

The ear is thoroughly cleansed by filling up the external meatus with some warm hydrogen peroxide (vols. 10) and leaving it in for at least fifteen minutes, and then gently syringing with a mild lotion such as a solution of boric acid or potassium permanganate, or a 1 per cent. solution of lysol or creolin. If the discharge is offensive, a solution of biniodide of mercury, 1 in 3,000 may be used. The ear is then carefully dried. If all the moisture cannot be removed by simply mopping out with pledgets of wool, this can usually be effected by gentle inflation of the ear, as a result of which the secretion will be expelled into the external meatus; or it may be sucked out by means of Siegle's speculum. If there is very little secretion, after drying the ear, some finely divided boracic powder is puffed in by means of an insufflator, and the auditory canal afterwards lightly plugged with a strip of gauze. The treatment should be repeated as soon as the gauze becomes saturated with secretion; if necessary, twice daily. In some cases, however, boracic acid is not well tolerated and tends to cause irritation. In order to remove the crusts or inspissated purulent secretion, it may be necessary at first to give daily an ear-bath of hydrogen peroxide. Those cases do best when strict asepsis is employed, and especially when the surgeon himself can personally change the dressings. If the treatment has to be carried out at the patient's home, it is wiser to employ the dry method of treatment; that is, on removing the gauze the ear should be merely mopped out with pledgets of wool, dried, and a little powder puffed in; this should be repeated once or twice daily. Very often this simple treatment will cure a middle ear suppuration if its continuance has been due to neglect.

If the secretion does not rapidly diminish, a few drops of rectified spirits, containing 10 grains of boric acid to the ounce, may be instilled into the meatus after the ear has been cleansed and dried (if the spirit-drops give rise to pain, they may be diluted with equal parts of water). After leaving the drops in for a few minutes, the excess of fluid is mopped out of the ear, and a gauze drain inserted. This should be repeated twice or three times a day. More astringent solutions may be prescribed, such as rectified spirits containing 2 to 5 grains of salicylic acid to the ounce ; solutions of silver nitrate 1–3 per cent. ; argyrol 10 per cent. ; or alumnol 5 per cent. Solutions of silver nitrate or salicylic acid may be used up to a strength of 10 per cent., but then only by the surgeon himself. Before using these strong solutions, the mucous membrane should be rendered anaesthetic by the previous instillation of a few drops of a solution of cocaine : the ear is then dried. A tiny fragment of wool, held by a pair of forceps, is dipped into the solution, which is lightly painted over the surface of the inner wall of the tympanic cavity. This treatment should not be repeated more frequently than once a week, the ear being meanwhile protected with gauze which should be changed when it becomes moist.

In some cases, in spite of the above treatment, healing is delayed from inspissated pus collecting in the floor of the tympanic cavity. If the perforation is large and situated in the lower half of the membrane, good results are sometimes obtained by inflation and afterwards sucking out the secretion by means of Siegle's speculum, or by actually washing out the tympanic cavity viâ the Eustachian tube. The catheter is passed in the ordinary way and the ear inflated to show that the catheter is in the correct position. The head is tilted over towards the affected side and then by means of a small syringe, whose point accurately fits the wider extremity of the catheter, some warm boracic lotion is syringed through the Eustachian tube into the tympanic cavity, whence it flows out of the external meatus. Air is then inflated through the catheter, the tympanic cavity thoroughly dried by small mops of wool, and some boracic powder puffed in, and a gauze strip inserted.

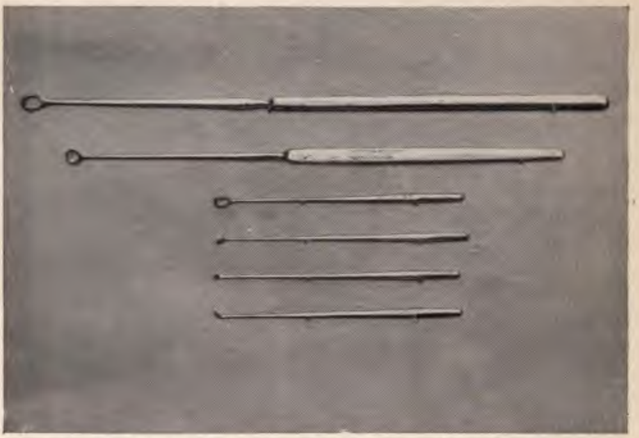
In other cases the chief reason for delay in healing is due to the continuance of a post-nasal catarrh causing repeated infection of the tympanic cavity through the Eustachian tube. If the discharge ceases, the inner wall of the tympanic cavity may again become normal and the hearing fairly good. The patient should be warned of the liability to recurrence of middle ear suppuration from outside infection or irritation. On this account he should keep the ear protected for a considerable time with a small piece of wool and should avoid water getting into the ear. Bathing must be forbidden.

2. *If the perforation is small* delay in healing is usually due to insufficient drainage. This is especially so if the perforation be situated in the upper quadrants. In these cases there may be recurrent attacks of headache and earache from retention of the secretion.

After cleansing the ear in the ordinary way an attempt should be made to suck out the secretion by means of Siegle's speculum. When this method fails, the perforation should be artificially increased in a downward direction by means of a paracentesis knife or, better still, a small piece should be punched out by means of tiny punch forceps. Gentle politzerization followed by suction with Siegle's speculum will assist the removal of the secretion.

Recovery may sometimes be hastened by the instillation of astringent and aseptic drops consisting of zinc sulphate grains 4, alcohol and hydrogen peroxide of each half an ounce. In order that these drops may penetrate into the tympanic cavity through the small perforation, the patient should recline with the affected ear uppermost and, after pouring the drops into the external meatus, the tragus should be pressed inwards several times in rapid succession by means of the finger, or whilst the head is held in this position the ear may be gently inflated by Politzer's method.

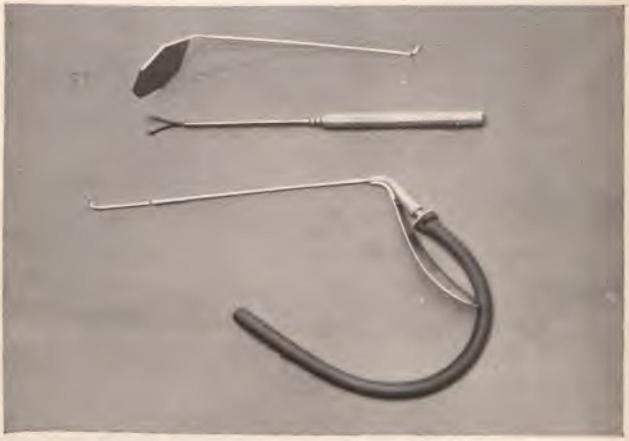
Granulations.—The presence of small granulations is often due to neglect of treatment and from the ear being in a septic condition. For this reason treatment should be begun by syringing out and drying the ear and afterwards instilling a few drops of 1 in 2,000 solution of biniodide of mercury in alcohol. After a few days, instillations of the more astringent drops may be prescribed. Single granulations are more effectively treated by touching them, under a local anaesthetic of cocaine or eucaine, with a tiny piece of chromic acid fused on to a probe, with a saturated solution of trichloracetic acid, or with the galvano-cautery. After using cauterizing



INSTRUMENTS FOR INTRA-TYMPANIC OPERATIONS.

1, 2, 3. Curettes for removing granulations. 4, 5, 6. Knives for cutting through adhesions.

3, 4, 5, 6 are used with handle for paracentesis knife shown in Plate XI, Photo 2, Fig. 2.



INSTRUMENTS USED IN "ATTIC" DISEASE.

1. Probe. 2. Wool-carrier. 3. Attic cannula (Milligan's pattern).

[*Plate XIII.*

agents, there may be a certain amount of inflammatory reaction. To prevent after pain, and at the same time to keep the ear dry, some orthoform powder may be insufflated. The after treatment consists in the frequent instillation of spirit drops. Cauterizing should not be repeated more frequently than once a week. When the granulations are large they can sometimes be picked off with tiny punch forceps (Plate V) or snared off, their base being afterwards cauterized, or if they are multiple and limited to the inner wall or floor of the antero-inferior portion of the tympanic cavity they may be removed by means of a curette. (Plate XIII.) These slight operations can generally be done under a local anaesthetic of cocaine or eucaine. If the patient is nervous, a general anaesthetic may be necessary. *Curetting the ear should never be done in a haphazard manner, but always with the assistance of a speculum and reflected light.* In order to avoid haemorrhage, the cocaine or eucaine may be dissolved in a 1 in 2,000 solution of adrenalin.

Recently Dr. Neumann of Vienna has been using a modification of Schleich's solution for the purpose of rendering the external meatus and tympanic cavity anaesthetic. This method consists in injecting under the periosteum a mixture of a 1 per cent. warm cocaine solution containing 5 drops of a 1 in a 1,000 adrenalin chloride solution to each cubic centimetre of cocaine solution.

Technique of the subcutaneous injection.—The auricle and external meatus are surgically cleansed. A large sized speculum is inserted into the external meatus and pressed inwards until the formation of a whitish wrinkle of skin indicates the termination of the cartilaginous portion ; the needle of the syringe (*see* Plate XI) is made to pierce the fold of skin at this point and a few drops of the solution are injected. The needle is now pressed in further and more fluid injected. The chief difficulty of the injection is to prevent puncture of the lining of the canal which is so closely adherent to the bone. If the injection has been successful a white bulging of the superior wall of the meatus will be seen. In addition to this injection the external meatus and tympanic cavity may be plugged with a tampon soaked in a strong solution of cocaine and adrenalin chloride. Anaesthesia will not occur for 15 or more minutes and should last for half an hour. Sometimes the anaesthesia produced is excellent ; at other times the pain of injection is so great that the patient refuses to permit its continuance.

Polypi.—They should be removed. The ear is cleansed and dried. The operation is performed either under a local anaesthetic or a general anaesthetic of gas and oxygen. The latter is preferable, especially if the polypus is large and completely fills the external meatus, as in these cases it is difficult for local anaesthetics to act effectively. The polypus is removed by means of a Wilde's snare (Plate XI) fitted with fine malleable copper wire. The wire loop is passed over the polypus and the snare is then pushed along the posterior upper border of the meatus until it almost reaches the tympanic membrane. The loop is then tightened until the snare is felt to firmly grip the neck of the polypus, which is then removed by means of gentle traction. If the polypus is small and the perforation large, its attachment to the inner or upper surface of the tympanic cavity may be seen and the snare can be then accurately passed round its pedicle and the polypus completely removed. When, however, the polypus completely fills up the external meatus, its complete removal is often difficult. After removal of the growth, there may be haemorrhage, which soon ceases. The ear is then syringed out with a mild antiseptic lotion and a drain of gauze inserted. For the week or 10 days succeeding the operation, treatment should consist in frequent instillation of spirit drops, only syringing out the ear for the purpose of cleansing. The ear is again examined and any remains of polypoid growth can be removed by means of the snare or curette or its base may be touched with some cauterizing agent.

The Prognosis should be guarded, as it is often impossible to say how extensive is the disease within the tympanic cavity until the polypus itself has been removed. Other polypi and granulations may then be seen to come from the attic or region of the antrum, or the probe may show the presence of extensive bone disease. *The polypus should not be removed without first explaining to the patient that it is merely a symptom of disease, and that sometimes as a result of its removal more urgent symptoms of mastoid disease may occur,* necessitating further operation. Owing to this possibility the patient, after removal of a large polypus, should not be permitted to go beyond call of his medical attendant. When the polypus is very large it is sometimes impossible to say from what point of the tympanic cavity it originates. Cases are known where, as the result of removal of the polypus, death has occurred within two or three days from meningitis. In these cases, however, the polypus has not been removed in a careful manner but either by forcibly extracting it with a pair of forceps or by blindly curetting the ear.

Attic suppuration tends to resist treatment owing to the smallness of the perforation and the difficulty of obtaining proper drainage. Very often crusts fill the opening and periodically give rise to symptoms of retention of the discharge. After removal of the crusts the cavity should be washed out by means of a special syringe known as Hartmann's cannula which consists of a fine silver tube with its tip bent at right angles to the shaft (*see* Plate XIII). To this cannula is attached some india-rubber tubing, the other end of which is fitted to a glass reservoir which may be filled with a warm solution of boracic acid, potassium permanganate, lysol or creolin. The reservoir should be held two or three feet above the level of the patient's head. As the insertion of the cannula into the attic perforation is often painful, the ear may first be rendered insensitive by using a 5 per cent. cocaine solution. If the patient is nervous the head should be supported by an assistant. The tip of the cannula is inserted through the perforation and the cavity is washed out by the lotion which is allowed to flow for a minute or two. Often no actual pus comes away, but rather tiny clumps of epithelial débris. If syringing with a mild lotion does not bring about a cure, after thoroughly drying the attic by means of tiny pledgets of wool inserted into the perforation, a few drops of rectified spirits, or a 2–3 per cent. solution of silver nitrate may occasionally be injected into the cavity. If this treatment is unsuccessful, as much as possible of Shrapnell's membrane may be cut away by a tiny knife, under a local anaesthetic, the attic cavity being afterwards gently curetted. If granulations are present they should be removed. If the disease is limited to the neck of the malleus, the prognosis is often good. If there is more extensive disease of the ossicles or walls of the attic, or of cholesteatomatous formation, as a rule healing does not take place and operative measures become necessary.

The operation of ossiculectomy (removal of the malleus and incus) was first proposed by Schwartze in 1873. In cases of attic suppuration, in addition to removal of the malleus and incus, the outer wall of the attic is sometimes also removed.

Indications for the operation are:—(1) Chronic suppuration of the tympanic cavity with disease of the malleus or incus, provided ordinary conservative measures have failed to cure, and there are no signs of mastoid disease.

(2) Chronic attic suppuration which conservative measures have failed to cure, and where in addition there is marked deafness.

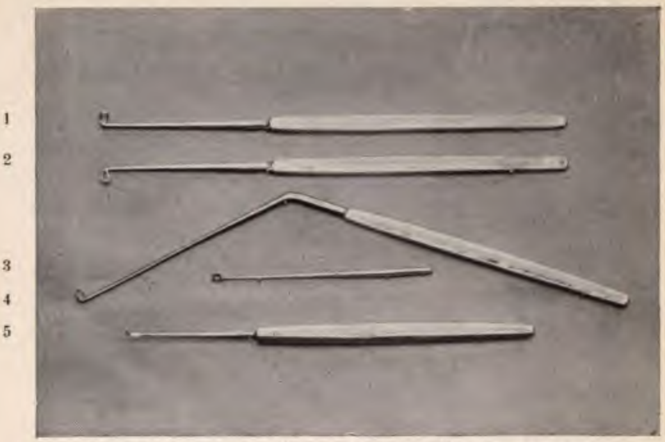
(3) In a certain number of cases although all the signs and symptoms are present warranting the complete mastoid operation, the patient may refuse such radical treatment. In these cases ossiculectomy and removal of the outer wall of the attic with as complete curetting as possible of the attic and antrum may be advised. Although this may not cure the suppurative process, by allowing free drainage it will diminish the risk of future intracranial trouble. In a certain number of these cases ossiculectomy has surprisingly good results.

(4) In cases of marked middle ear deafness in which, as the result of post-suppurative adhesions, the malleus is bound down to the inner wall of the tympanic cavity and there is reason to hope that by removal of the remains of the tympanic membrane with the malleus and incus improvement in hearing may be obtained. The chances of success or failure of this operation should always be explained to the patient and the operation should only be recommended as a last resource when there is marked deafness of both ears.

In most cases if the hearing is good and there are no symptoms of headache, neuralgia or earache, the patient prefers to continue conservative treatment until more urgent symptoms occur, but the surgeon should be careful to explain the risks of future complications. Many of these cases continue to the end without any urgent symptoms ever occurring, but so long as an attic suppuration continues it is impossible to foretell what may happen.

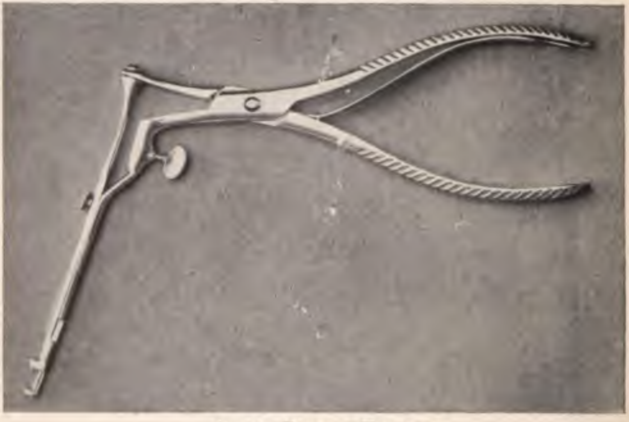
This operation is contra-indicated, although unfortunately sometimes advised, *as a means of improving hearing in cases of chronic middle ear catarrh or otosclerosis.*

Technique of the operation.—When possible this should be performed under a general anaesthetic. The auricle and auditory canal are thoroughly cleansed and dried, and the meatus is filled with a sterilized solution of 1 in 2,000 adrenalin chloride in order to diminish haemorrhage. This takes effect whilst the patient is being anaesthetized. The side of the head is covered with a sterilized towel or piece of lint in which an opening for the ear has been made. The speculum used



INSTRUMENTS FOR OPERATION OF OSSICULECTOMY.

1, 2. Zeroni's incus hook. 3. Attic curette. 4. Ring knife. 5. Schwartze's tenotomy knife.



ATTIC PUNCH FORCEPS.

For removal of outer wall of attic.

[*Plate XIV.*

should be as large as possible. A good light is necessary. The tympanic membrane is incised round the handle of the malleus by means of a small paracentesis knife, care being taken to cut through the anterior and posterior folds. The tendon of the tensor tympani muscle is cut through by passing a Schwartze's tenotomy knife high up between the malleus and incus and turning it forwards and downwards behind the neck of the malleus between it and the inner wall of the tympanic cavity. (Plate XIV.) Wilde's snare (Plate XI) is now introduced and the loop of the snare is passed round the handle of the malleus and pushed upwards to its neck; the loop is tightened so as to grip the malleus, which is in this way removed by the snare. Another method is to pass a small sharp ring knife around the malleus and direct it upwards until it cuts through the tendon of the tensor tympani, the malleus being then extracted by gentle traction. Extraction is sometimes easy, sometimes difficult, depending on the size of the auditory canal and the firmness with which the malleus is adherent to the inner wall of the tympanic cavity. When granulations are present they should first be removed by gentle curetting, all haemorrhage being afterwards arrested by firmly plugging the auditory canal for a few minutes with gauze soaked in adrenalin solution.

The incus is now removed by Zeroni's incus hook, which consists of a steel eyelet with a backward curve situated at right angles to the extremity of the shaft of the instrument. The instrument is inserted into the attic, the eyelet pointing upwards, into the space occupied by the head of the malleus: it is then rotated backwards and downwards so that the eyelet passes over the body of the incus and forces it out into the tympanic cavity. I personally prefer this instrument to Ludwig's or any other incus hook, as being absolutely certain in its action; and owing to its shape it is almost impossible to injure the facial nerve. After removal of the incus, if the size of the auditory canal permits it, the outer wall of the attic may be removed either by punch forceps or a tiny burr. Any granulations in the attic or region of the antrum are removed by means of a curette. The ear is afterwards syringed out and dried, and a small drain of gauze inserted.

After treatment.—As a rule there is not much pain and the gauze only requires to be changed every second day. The ear is only to be syringed if there is much secretion. The instillation of spirit drops containing 10 grains of boric acid to the ounce, three times a day, is the best form of treatment. If the operation has been successful the discharge rapidly diminishes and very often the ear becomes completely dry within a month after the operation has been performed. In some cases there may be a temporary inflammation of the auditory canal the result of the operative manipulation. This may cause considerable pain within the ear and also of the auricle; it can usually be relieved by the instillation of some drops of a 10 per cent. solution of carbolic acid in glycerine, and by applying moist compresses of cold boracic or evaporating lead lotion to the affected side of the head.

Mishaps.—The chief danger is injury to the facial nerve by means of the incus hook or from the violent curetting of the inner wall of the ear. During the operation the anaesthetist should carefully watch the face to see if any twitching takes place. Meningitis has been known to occur as the result of septic infection through injury to the inner wall of the middle ear. This, however, is fortunately a very rare calamity.

In the great majority of cases the result of the operation is most satisfactory. If there is a continuation of the suppuration, or the recurrence of granulations or polypi in the upper posterior quadrant it means that the mastoid region is also affected, and the question will then arise as to whether the complete post-aural operation should be performed or not.

Prognosis of chronic middle ear suppuration.—Over fifty years ago Wilde said with regard to middle ear suppuration, that it was impossible to say how, when, or where it might end, and the truth of this saying still remains.

Until a middle ear suppuration has been cured, a definite prognosis with regard to recovery without operative treatment cannot be given; neither can be foretold what complications may arise in the course of the disease.

The prognosis is favourable if the patient is healthy, if the cause of the suppurative process is one that can be removed, and if there are no signs of caries of the bony walls. Suppuration may cease, but if the perforation remains relapses are not uncommon. Cessation of the discharge does not necessarily mean a cure; in many cases of chronic disease of the attic the formation of crusts or cholesteatoma may continue unnoticed until the sudden occurrence of an acute inflammation of the mastoid process or of some intracranial complication. If the perforation is large and accompanied only by a slight mucoid secretion with free drainage, there is very little risk of any serious complication ever occurring, especially in old people in whom the condition may have existed for years. Prognosis is unfavourable if the suppuration is the result of a specific fever or tuberculosis, if the patient is in bad health, or if there is cholesteatomatous formation or evidence of bone disease.

Results of chronic middle ear suppuration.—(1) Cure with healing of the perforation by scar tissue and recovery of normal hearing.

(2) Cessation of the discharge, the perforation remaining; this is known as a *dry perforation.*

(3) Cessation of the discharge with the formation of post-suppurative adhesions binding down the ossicles and membrane partially or completely to the inner wall of the tympanic cavity.

(4) Cessation of the discharge after extensive destruction of the bony walls with or without exfoliation of the ossicles (usually the result of specific fever) in which the attic and entrance to the antrum may be exposed to view.

(5) Formation of cholesteatoma.

(6) Caries or necrosis of the walls of the tympanic cavity and involvement of the mastoid process.

(7) Intracranial complications.

Treatment of post-suppurative changes.—(1) *A dry perforation.* Even although the discharge has ceased, the presence of a perforation invites relapses from infection from without. The chief cause for the non-healing of the perforation is an ingrowing of the outer epithelial layer from its edge. Attempts have been made to induce healing by touching the edge of the perforation with the galvano-cautery or trichloracetic acid, but this is usually only successful in the case of a small perforation. The procedure also involves a slight risk of again setting up a middle ear suppuration.

(2) *Post-suppurative adhesions.*—If the adhesions are not extensive and there is movement of the drum, especially in the region over the stapes and the fenestra ovalis, considerable improvement may be obtained by catheterization combined with pneumatic massage. In these cases more permanent improvement can sometimes be gained by cutting through the adhesions by means of intra-tympanic incisions or by the removal of the remains of the membrane with the malleus and incus. The after results of intra-tympanic incisions are usually not successful owing to the reformation of fresh adhesions. Ossiculectomy is only justifiable if there is marked deafness (ordinary conversation heard less than 10 feet off), if the tuning fork tests show that there is no impairment of the internal ear, if the membrane is found to be movable over the region of the stapes, and if a temporary improvement is obtained after use of the catheter and masseur. The risks of the operation are : No improvement in hearing, or, if improvement is obtained, a recurrence of the deafness from re-formation of the adhesions. Also there is a possibility of setting up a further attack of middle ear suppuration. On the other hand, this operation may give surprisingly good results.

(3) *Bulging scars, and flaccid membrane.*—In some cases as a result of over politzerizing or from repeated attempts to inflate the ear by Valsalva's method, the

membrane, which may have become atrophic or partially replaced by scar tissue, tends to become flaccid and alternately bulge outwards or sink inwards on to the inner wall of the tympanic cavity according as the pressure within the tympanic cavity is increased or diminished. This is especially so when the malleus has become adherent to the promontory. Attempts have been made to improve this condition by linear scarification of the membrane, or by trying to fix the membrane as it bulges outwards with flexile collodion. These methods are rarely successful.

Removal of the stapes has been suggested as a means of improving the hearing in cases of deafness due to middle ear suppuration. Up to the present the results of this operation do not suggest it being of any great value, if even justifiable.

Artificial aids to hearing consist in artificial eardrums, ear-trumpets, and speaking tubes, and mechanical appliances for increasing sound. *They are useless in internal ear affections, but are often of service in deafness due to disease of the conductive portion.* In chronic middle ear catarrh and in otosclerosis, or if the membrane is adherent to the inner wall by scar tissue, an artificial drum is of no benefit. It is only of value in old cases of middle ear suppuration where there is a non-adherent perforation, and in which the stapes is still freely movable in the fenestra ovalis. The best artificial drum is a cone of cotton wool moistened with a drop of sterilized glycerine, which is inserted by a pair of forceps into the auditory canal until it reaches the drum surface. If the perforation is very large, the plug is inserted until it comes into contact with the inner wall of the tympanic cavity. In most cases the patients discover for themselves the best method of introducing these plugs, and after a little practice generally manage to do so with great skill. An artificial ear-drum should only be used after the secretion has almost ceased; the irritation caused by the plug may set up further suppurative trouble. At first the plug should only be worn for a very short time, and the period for which it can be left in the ear will have to be determined, according to its irritating effect. If, however, discharge is set up, the ear is best treated by frequently instilling a few drops of rectified spirits containing some boracic acid (gr. x. to ℥i). In some cases the artificial drums are so well borne that the patient wears them for days and weeks without any bad effect. This practice, however, should be discouraged. The drum should only be worn when it is a matter of necessity for the patient to make the best possible use of his hearing power.

In ordering the patient an ear-trumpet, he should be warned that the *small trumpets are valueless.*

A speaking tube should be reserved for those who are very deaf, as it is more powerful than the ear-trumpet. Whether the persistent use of the ear-trumpet may lead to the more rapid progress of the deafness, as is stated by some, is very doubtful. There is no doubt that the use of the ear-trumpet or speaking tube in many cases makes life more pleasant, as it enables the patient to take part in conversation from which he would otherwise be excluded.

It is impossible to exaggerate the importance of impressing on the general public their extreme foolishness in buying and using artificial aids for hearing, or artificial drums, without having first consulted their medical man. The object of the quack who sells such instruments is to make money, and therefore the advertisement with which he puffs his wares is skilfully worded so as to induce the ignorant to believe that the purchase of an artificial drum or mechanical apparatus will relieve or permanently cure every possible form of deafness. On the other hand, it does not follow because artificial ear-drums or other instruments are exploited by a quack that they will necessarily be useless articles. In certain conditions they may be of possible value.

CHAPTER IX

DISEASE OF THE MASTOID PROCESS

ANATOMY.—*The mastoid antrum* communicates with the tympanic cavity by means of a small opening, the aditus. At birth, it is almost of normal size forming with the attic a cavity about the size of a pea.

It is enveloped, with the exception of its inner and anterior surfaces, by the mastoid process which is developed after birth by the outgrowth of cells from the antrum into the bony tissue surrounding it.

In the adult the antrum is somewhat deeply placed, being situated at a depth of a half to three-quarters of an inch from the surface of the bone.

Its roof is continuous with that of the attic, being formed by the tegmen tympani ; anteriorly it is separated from the external auditory meatus by a bridge of bone forming the posterior wall of the auditory canal, at the inmost point of which is the aditus ; on its inner wall lie the semi-circular canals ; posteriorly is the lateral sinus separated from the antrum by a layer of mastoid cells.

Between the semicircular canals and the lateral sinus is a small area composed of a thin layer of bone separating the antrum from the posterior fossa of the intracranial cavity.

The size of the antrum varies and in some cases its floor may be at a considerable distance beneath the level of the aditus.

The mastoid process only approaches the adult type at the end of the third year. Most of its cells converge towards the antrum, with which many directly

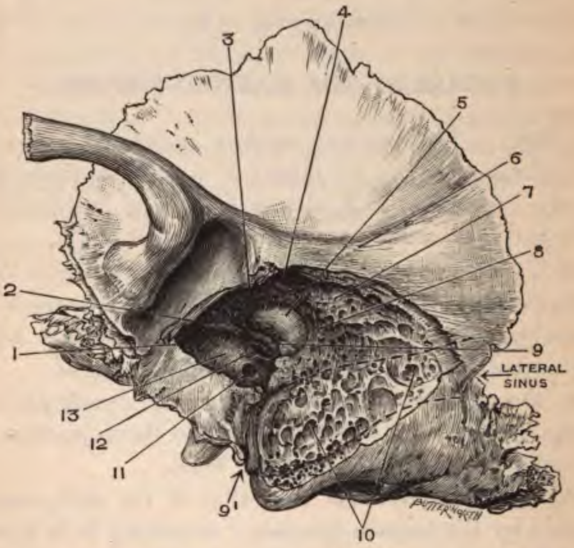


FIG. 7.—To show the anatomy of the Middle Ear and Mastoid Process. (Drawn from a preparation in author's collection.)

1. Anterior wall of external meatus partially removed.
2. Canal for tensor tympani muscle, ending in processus cochleariformis.
3. Attic.
4. Aditus.
5. External semicircular canal.
6. Posterior root of zygoma.
7. Tegmen tympani.
8. Antrum.
9. Fallopian canal for facial nerve.

9^1. Stylo mastoid foramen.

10. Mastoid cells.
11. Fenestra rotunda.
12. Fenestra ovalis.
13. Promontory.

Dotted lines show outline of sigmoid groove for lateral sinus.

or indirectly communicate; they are arranged into two chief groups—one group extends vertically downwards to the tip of the mastoid, the other lies behind the antrum, between it and the sigmoid portion of the lateral sinus. Its cells, however, may reach beyond the upper wall of the meatus even as far as the root of the zygoma or extend backwards and communicate with the cells of the occipital bone: they may also be found on the floor of the tympanic cavity between it and the jugular fossa, or envelop the orifice of the Eustachian tube, or spread inwards towards the apex of the petrous bone surrounding the labyrinth.

The structure of the mastoid process varies, but three chief types are recognized (1) *the pneumatic*, in which the cells are few and large, (2) *the diploic* containing numerous small cells, and (3) *the compact*, in which the bone is extremely dense. The latter is probably always the result of osteosclerosis due to chronic inflammation of the mastoid process. In many cases, mixed types are found.

Surface anatomy—The posterior root of the zygoma marks the upper boundary of the antrum and mastoid process and the lowest limit of the middle fossa of the skull. Just behind the auditory meatus, at its upper posterior margin, is the spine of Henlé, which forms the anterior margin of the suprameatal triangle. A point 10 millimetres (two-thirds of an inch) behind the spine of Henlé corresponds to the anterior border of the sigmoid sinus as it turns downwards towards the tip of the mastoid to end in the jugular fossa. Just behind the external meatus and beneath the zygomatic ridge is the body of the mastoid, which has a smooth surface and is punctated by small foramina, through which tiny vessels pass: this is the usual spot for a fistula to occur in acute mastoid disease. The suprameatal triangle is given as the superficial landmark corresponding to the antrum, but it is an uncertain one. (Fig. 10, p. 207). The antrum is situated at a slightly higher level than the tympanic membrane; its floor roughly corresponds with the middle of the posterior wall of the meatus.

In an infant, the mastoid process is rudimentary, the antrum is very superficial, and the tympano-mastoid fissure separating the tympanic bone from the anterior margin of the mastoid process, and the squamo-mastoid suture passing down across the outer wall of the antrum, are still patent.

It is almost impossible to foretell the structure of the mastoid process, the exact position of the antrum, or the lateral sinus, or the lowest limit of the middle fossa before actually opening the bone. Experience, however, has shown that in dolichocephalic skulls the mastoid process is often chiefly composed of large cells, that the floor of the middle fossa does not extend so low down, that the lateral sinus does not come so far forward, nor is it so superficial as in cases of the brachycephalic type. In the latter there is a tendency for the mastoid process to consist of dense bone, for the middle fossa to overlap the outer wall of the antrum, and for the lateral sinus to project forwards, even to within two or three millimetres from the posterior border of the external meatus.

ACUTE INFLAMMATION OF THE MASTOID PROCESS

Ætiology and Pathology.—Inflammation of the mastoid process is practically always secondary to an acute middle ear inflammation or suppuration. Periostitis of the mastoid process may occur as the result of traumatism or in rare occasions as the sequela of furunculosis of the posterior wall of the external meatus; otherwise it is secondary to inflammation of the bone. Primary abscess of the mastoid is almost unknown, except as a metastatic abscess in the course of pyaemia or as the result of specific fevers. In almost every case a history can be obtained of a recent inflammatory affection of the middle ear, the symptoms of which may have passed away before the mastoid process shows any symptoms of disease. True primary osteitis or caries of the mastoid process may occur as the result of syphilis or tuberculosis.

According to Politzer, in every case of acute middle ear suppuration, the mucous membrane lining the antrum and mastoid cells is involved to the same degree as that of the tympanic cavity. In the majority of cases, if there is free drainage, the inflammation of the mucous membrane gradually subsides and again becomes restored to its normal condition. *Ceteris paribus*, acute inflammation of the mastoid is more likely to occur when the anatomical conditions favour insufficient drainage and the retention of the purulent secretion within the antrum and mastoid cells; that is in cases where the aditus is small, the antrum is large, and the mastoid process is of the pneumatic type.

When the infection is very virulent, acute inflammation of the bone may occur, in spite of free drainage ; as a rule, however, it is the result of retention of the purulent secretion, which fills up the antrum and the adjoining mastoid cells. Normally the pus escapes by the most direct route, which is through the aditus into the tympanic cavity. If, however, the drainage is insufficient, the underlying bone becomes involved in the inflammatory process and caries takes place along the path of least resistance, thus allowing an escape for the purulent contents. As the inflammatory process spreads to the surface of the bone, periostitis usually occurs. After perforation of the bone has taken place, an accumulation of the purulent secretion between the bone and the periosteum gives rise to an abscess over the mastoid process.

In some cases the bone disease seems limited to cells which do not appear to be in communication with the antrum, although the cells must have originally become affected from the antral cavity.

The paths by which the pus escapes are—1. Most frequently through the outer surface of the mastoid process. (*a*) In infants or young children this may occur without destruction of the bone, owing to the pus forcing its way through the squamo-mastoid suture. In infants, also, the pus may make its exit along the posterior margin of the external auditory meatus between the periosteum and bone to the outer surface of the mastoid process ; in these cases there may be no perforation of the tympanic membrane. (*b*) In older children and adults, after the squamo-mastoid suture has become obliterated, the pus has to penetrate through the bone tissue itself. The fistula is usually situated in the body of the mastoid process a little way behind the level of the external auditory canal.

2. The pus may track downwards and break through the bone at the inner surface of the tip of the mastoid process forming an abscess in the neck beneath the fascia of the sterno-mastoid muscle. This only occurs when the tip of the mastoid process is composed of large cells. This is known as **Bezold's mastoiditis,** and is usually found in adults.

3. The pus may break through the tegmen tympani above, or posteriorly into the sigmoid groove with the formation of an extradural abscess, which in the latter case will cover the outer wall of the sigmoid sinus.

4. Only rarely does the pus track inwards with involvement of the labyrinth. (Figs. 13 and 14, pp. 241, 242.)

The symptoms vary according to the virulence of the infection, the resistance to the outflow of the pus, and the stage at which the patient comes under observation.

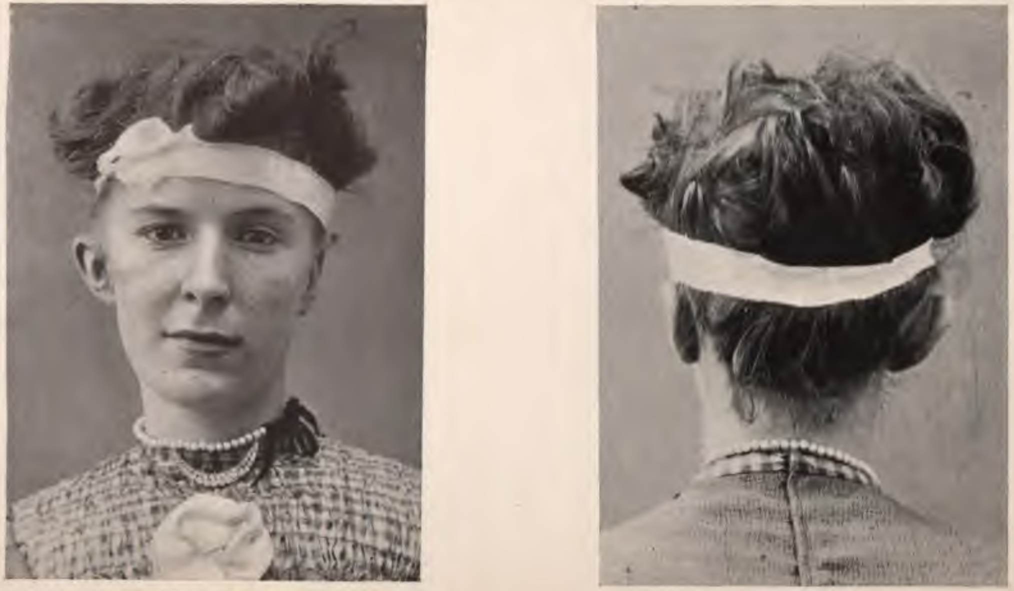
In a typical case there is a history of acute middle ear suppuration of some three or four weeks duration, during which period, in spite of profuse discharge, there may have been a slight rise of temperature in the evening, some feeling of fullness and heaviness in the head on the affected side, accompanied by occasional twinges of pain over the mastoid region, which is usually tender on pressure. The auricle is noticed to project slightly from the head and a swelling to appear above and behind it. As a rule the patient looks ill and tired, partly from lack of sleep, and from the gnawing and neuralgic pains in the head, and partly from septic absorption. There is often loss of appetite and a general feeling of malaise, and constipation.

Occasionally acute inflammation of the mastoid process occurs within a few days after the onset of middle ear suppuration. In such cases the symptoms, owing to the intensity of the inflammatory process, may be severe. There may be intense earache and high fever; and in children there may be vomiting, convulsions, or symptoms of cerebral irritation. On the other hand, if the involvement of the bone is a gradual process, the constitutional symptoms may be entirely absent, and the first sign of the disease may be a swelling behind the ear. This is more usual in cases where the mastoid process is of the pneumatic type.

Pyrexia is a varying symptom. It is usually present and may be marked during the first few days, but after the pus has escaped either into the tympanic cavity or by forcing its way through the bone the temperature again becomes normal. *The continuance of pyrexia is a grave sign, and is one of the most urgent indications for operative treatment.* A normal temperature does not negative disease of the mastoid process and is not uncommon when there is free exit of the purulent discharge. Thus it often happens that in cases in which a mastoid abscess has already formed, the temperature is normal and there are no constitutional symptoms, whereas if the mastoid process is sclerosed and the resistance to the escape of the purulent contents is great, although there may be no external signs of disease, the fever remains high and the pain severe.

Objective signs.—As a rule, the otorrhoea is pro-

TO SHOW DISPLACEMENT OF AURICLE IN "MASTOID ABSCESS" OF RIGHT EAR.



Front View.

Back View.

[*Plate XV.*

fuse, but, sometimes, as a result of retention of the purulent discharge, the symptoms of inflammation of the mastoid process are noticed only to occur after the otorrhoea has ceased.

In rare cases there is no otorrhoea, owing to the membrane not having perforated; this is more frequently seen in young children, or in adults as the result of influenza. On examination, the walls of the meatus may be so swollen as to prevent a view of the deeper parts.

If there is involvement of the cells of the anterior wall of the antrum and mastoid process, *the upper posterior part of the auditory canal may bulge downwards* so that the bony meatus has a slit-like appearance; this condition is almost pathognomonic of acute mastoid disease. A view of the tympanic membrane shows the same changes as in acute middle ear suppuration but the perforation is often small and situated at the apex of a nipple-shaped protuberance in the upper posterior part of the membrane.

Owing to the anatomical fact that the antrum and body of the mastoid process are situated above and behind the auricle, any inflammatory thickening of the periosteum or soft tissues, or the formation of a sub-periosteal abscess in this position, will cause the auricle to project away from the head in a downward and forward direction. *This displacement of the auricle is characteristic of inflammation of the mastoid process.* The change in position of the auricle is best observed by standing behind the patient and comparing the auricles and mastoid regions on both sides. Very slight changes may be recognized by the surgeon passing his fingers over both mastoid regions simultaneously, when a difference in their contour may be felt. On the affected side, owing to the thickened periosteum, the mastoid process will be felt to be thicker to the touch and less definite in outline than on the normal side. If a collection of pus has already formed between the periosteum and bone (the so-called *mastoid abscess*), it is situated close behind and above the auricle, so that it obliterates the retro-auricular fold. On palpation it fluctuates over its central part and its edges are found to gently shade off into the surrounding tissues. As a rule the abscess is limited to the post-aural region, but sometimes it is sufficiently large as to cause a swelling over the parietal region, or to extend backward towards the occiput. With this there may be considerable oedema of the surrounding skin. In children there is often enlargement of the cervical glands.

If the bone is very thick and sclerosed, acute inflammation of the mastoid process may be present without there being any external signs.

When a fistula has taken place through the inner surface of the mastoid process (*Bezold's mastoiditis*), the pus escapes into the digastric fossa beneath the fascia of the sterno-mastoid muscle, giving rise to a deeply situated abscess in the neck. This is usually accompanied by an indefinite infiltration of the subcutaneous tissues involving the lower part of the mastoid process and forming a semi-fluctuating mass which cannot be differentiated from its lower part. If the abscess approaches the surface, a red, brawny swelling may extend from the mastoid region for a considerable distance down the neck, and the head is usually held over to the affected side in order to relieve tension.

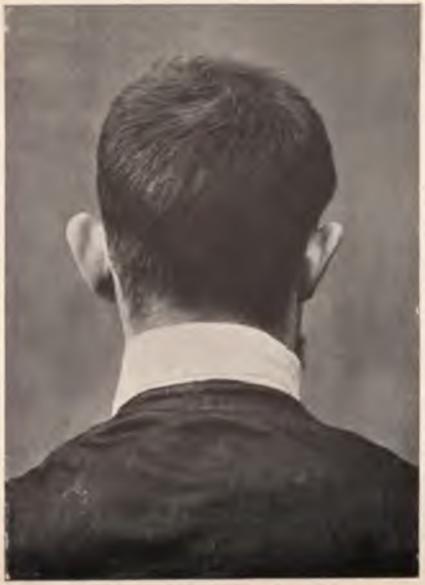
Palpation with the finger causes pain and tenderness over the mastoid process, which is often extreme at a point situated a short distance behind the level of the external meatus; there may also be pitting of the skin from oedema of the subcutaneous tissues, but, as a rule, the skin itself is found to be freely movable over the deeper tissues.

Diagnosis.—It is sometimes a matter of extreme difficulty to say whether the bone itself is affected or whether there is merely retention of pus within the antrum and adjoining mastoid cells (empyema of the antrum). This is especially the case if the otorrhoea has continued for over four weeks and is accompanied by occasional tenderness over the mastoid process. In some of these cases, as a result of conservative treatment, healing takes place; in others, after weeks perhaps, definite signs of disease of the mastoid process becomes apparent. In cases of doubt it is wiser to operate.

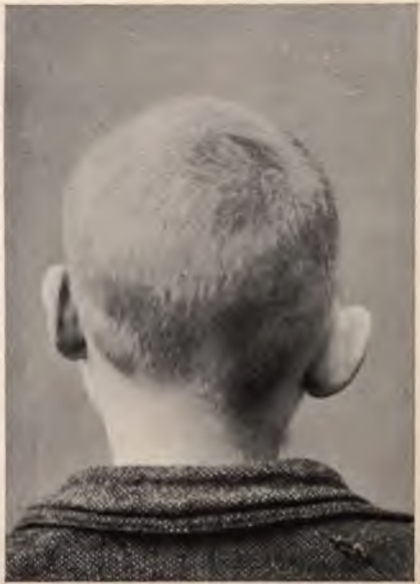
Although inflammation of the mastoid process may exist without any external signs, yet, on the other hand, there may be an apparent mastoid abscess without the presence of otorrhoea.

1. Acute mastoiditis with no external signs.—(*a*) This may occur in adults where there is extreme sclerosis of the mastoid process. There is usually tenderness over the mastoid process on deep pressure or percussion; the constitutional symptoms, such as pyrexia and head pain, are severe. This condition, owing to the retention of pus, is far more serious and requires more urgent treatment than those cases in which a "mastoid abscess" has already formed. (*b*) If the anterior wall of the antrum and mastoid have become involved, absorption of the bone may take place, allowing escape of the pus into the auditory meatus. In such cases the otorrhoea is usually profuse and the meatus is slit-like from bulging downwards of its upper posterior wall.

2. **Acute mastoiditis with external signs.**—(1) *Without Otorrhoea*—(*a*) The otorrhoea may have ceased owing to obstruction of the outflow of pus from the aditus: the tympanic cavity will show signs of a recent middle ear suppuration. (*b*) There may be a history of otorrhoea which has existed off and on for years. On examination of the ear, the tympanic cavity may be found to be blocked with granulations and polypi preventing the outflow of the discharge. This condition is really an acute exacerbation of a chronic inflammation of the mastoid process which will be discussed later. (*c*) There may be no otorrhoea owing to there being no perforation of the membrane. There is usually, however, a history of a recent otitis media which is often confirmed on inspecting the tympanic membrane. Diplococcal infection and influenza seem especially prone to give rise to acute mastoiditis after the acute middle ear inflammation has subsided. These cases are sometimes mistaken for, and called acute primary inflammation of the mastoid process. In some cases no pathological changes can be seen within the middle ear and there may be no deafness. The diagnosis has then to be made from the position of the mastoid abscess and by the exclusion of any other cause producing it. Plate XV gives the portrait of such a case in which there



To show Displacement of Auricle in case of Furunculosis of Left Ear.



To show Displacement of Auricle in case of Mastoid Abscess of Right Ear.

[*Plate XVI.*

were no constitutional symptoms, no pyrexia, no deafness and no apparent changes in the tympanic membrane yet, when I operated, the bone disease was so extensive that the dura-mater of the middle fossa and the lateral sinus lay exposed within the wound. (*d*) Primary tuberculous disease of the mastoid process may give rise to a mastoid abscess which is almost impossible to diagnose from the previous condition and is usually only discovered as the result of operation.

(2) *With Otorrhoea*—(*a*) *Furunculosis.* The signs of and symptoms of acute mastoid disease and of furunculosis of the external meatus have already been given but the differential diagnosis of these two conditions is so important that for the sake of convenience the main symptoms are again tabulated :—

FURUNCULOSIS.	ACUTE MASTOID DISEASE.
Onset and course rapid; symptoms most marked at the end of third day.	Onset gradual, not beginning before the third week after the onset of the acute middle ear suppuration.
Pain intense, increased on mastication and movement of auricle and on pressure with finger in front and below tip of mastoid process.	No pain on mastication nor movement of auricle, but tenderness on pressure over the body of the mastoid.
Auricle may be swollen and congested, and may project slightly outwards. (Plate XVI.)	Auricle normal but projects downwards and outwards from the head. (Plate XVI.)
There may be pitting of the skin on pressure owing to superficial oedema, which may extend over a large area above and behind the ear.	There may be pitting of the skin on pressure due to inflammation of the subcutaneous tissues over which the skin itself is usually freely movable.

The external meatus is obstructed by one or more localized swellings which are extremely tender on probing.	The meatus may be swollen from general thickening of its walls.
The discharge is slight and seems to come from the apex of the furuncle.	The discharge is profuse and, on cleaning the ear, may be seen to pulsate.
On examination with a speculum the drum may be seen to be intact.	On examination with a speculum a perforation will be seen.
If the meatus is not completely obstructed, the hearing may be normal.	There is usually marked deafness.

In addition to these main symptoms, the general constitutional symptoms will aid diagnosis. If middle ear suppuration and furunculosis of the external meatus occur together, it is sometimes extremely difficult to tell whether there is mastoid disease or not. If, after two or three days' treatment, the diagnosis is not certain, it is wiser to operate than to delay too long.

(*b*) *Abscess of the post-aural lymphatic gland.*—When there is no otorrhoea diagnosis is easy. If there is otorrhoea, the position of the abscess which is situated further behind the auricle so that the auricle does not project, and also the absence of any signs or symptoms pointing to mastoid disease should assist the diagnosis.

(*c*) Other conditions from which a diagnosis may have to be made are *sarcomata*, *lipomata*, *gummata*, or *dermoid cysts*.

Treatment.—**Conservative treatment** can only be expected to arrest the progress of the inflammation if the case is seen before the bone has actually become involved. If there are obvious signs of involvement of the bone, operative treatment is indicated.

The patient should be kept in bed, the diet should be light, but if there is much fever it must be restricted to liquids ; calomel should be given at night followed by a smart saline purge in the morning. The first step is to make certain that there is free drainage of the purulent discharge. The membrane, if not already perforated, should be freely incised, or, if the perforation is small, enlarged to relieve the pain and to assist the discharge. The ear should be frequently syringed with a hot mild antiseptic lotion. To arrest the inflammation and subdue the pain cold compresses of evaporating lead lotion or Leiter's coils may be applied to the mastoid process, but it is doubtful if this treatment can in any way arrest the progress of the disease. In other cases, comfort is derived from the application of compresses of hot wool or of a small rubber bag containing hot water. Narcotics may be given to cause sleep, but care must be taken that their soothing effect does not mask the symptoms of the disease.

In some cases, even where there is marked oedema over the mastoid process accompanied by tenderness on pressure, the symptoms may disappear as the result of paracentesis if the membrane is not yet ruptured, or by enlarging the perforation if it is too small ; as a rule, this only occurs in children. When the symptoms of acute mastoid inflammation have subsided, the after treatment is that already described for acute middle ear suppuration, but the possibility of future inflammation of the mastoid process must not be ignored.

Operative treatment.—Considerable advance has been made in recent years with regard to the method of operating on the mastoid process.

In acute inflammation of the mastoid, the object of the operation is to freely expose the antrum, in order to permit of free drainage of the purulent contents and also to remove any diseased bone. Excepting when the infection has been very virulent, as in cases of diphtheria or scarlet fever, the inflammatory process at first remains limited to the mucous membrane, the bone only becoming secondarily affected after some considerable period; and even when the bone of the mastoid process has become involved, the walls of the attic and the ossicles themselves appear to be more resistant and remain longer unaffected. For this reason operative treatment in these cases is limited to the mastoid process itself, and the greatest care is taken not to injure the tympanic cavity, so that after recovery has taken place there may be complete restoration of hearing. This operation was first introduced by Schwartze in 1873, and is now generally known as "*Schwartze's operation.*"

Wilde's incision.—Years ago, before surgeons performed the mastoid operation, Wilde, in cases of acute inflammation or of an abscess of the mastoid process, incised the tissues down to the bone by a post-aural incision. This, as an operative measure, is a thing of the past, excepting, perhaps, in tiny infants when it is possible, without any actual disease of the bone, for the pus to escape through the squamo-mastoid suture or between the periosteum and bone along the posterior wall just behind the auditory meatus. In older children and adults this operation is useless, as the abscess is due to bone disease. In some cases apparent healing may take place, but afterwards fistulae or evidence of chronic mastoid disease almost invariably occur.

Indications for Schwartze's operation.—(1) If, in spite of free drainage (obtained, if necessary, by paracentesis), earache, pyrexia, and tenderness over the body of the mastoid process do not abate within three days after careful conservative treatment.

(2) If there is an obvious abscess over the mastoid process.

(3) If, in spite of free drainage, there are symptoms of meningeal irritation. In children this may occur before perforation takes place. If the symptoms continue for over 24 hours after free drainage has been established, the mastoid antrum should be opened. In adults there must be no delay in opening the antrum, if the condition is influenzal in origin.

(4) If there is *profuse* otorrhoea lasting for over four weeks with sagging downwards of the upper posterior wall of the external meatus.

(5) If, in spite of no symptoms, there is no sign of cessation of the otorrhoea after eight weeks. If the posterior wall of the external meatus looks normal, the continuance of the otorrhoea in these cases is not usually due to bone disease of the mastoid process, but to the accumulation of pus in a large antral cavity, and the object of the operation is to allow for free drainage and to prevent the occurrence of disease of the bone.

(6) Although in cases of chronic otorrhoea the complete mastoid operation is usually the one indicated, yet if there are no symptoms of mastoid disease,

the continuance of the otorrhoea may be due to a chronic empyema of the antrum. In such cases Schwartze's operation may suffice. This operation should only be done if there are no polypi nor granulations, nor any evidence of diseased bone, and also if there is no internal ear disease. The possibility of failure and of the complete operation having to be performed later should be explained to the patient.

Terminations, if no operation is done.—(1) It is possible for recovery to take place from the purulent secretion draining into the tympanic cavity.

(2) An abscess over the mastoid process may spontaneously burst through the skin, leaving behind a fistula which may persist or eventually heal. This is most frequently seen in children.

(3) The case may end fatally from meningitis, extradural abscess, lateral sinus thrombosis or intracranial abscess.

Technique of the operation.—The patient is prepared in the ordinary manner. The head should be shaved for a space of two or three inches around the mastoid region, if possible, 24 hours before the operation. In women it is kinder not to shave the head in front of the ear as the hair takes so long to grow. The area of the operation and surrounding parts should be thoroughly washed with a soap solution and ether, and afterwards protected with a compress of a 1 in 2,000 solution of biniodide of mercury. The instruments required are few in number ; a scapel, some artery forceps, a malleable silver probe, a seeker, a small curette or Volkmann's spoon, two or three gouges of varying size, a chisel, and a mallet : they are sterilized in the ordinary way. The *seeker* consists of a fine steel probe with a blunted point, which is bent at right angles to the shaft. It is useful in examining for fistulae and openings in the bone, and in the complete mastoid operation can be used instead of Stacke's probe. (Plate XVIII.)

During the operation the head is supported on some hard substance, such as a small partially filled sand-bag; sterilized towels cover the head, with the exception of the area to be operated on.

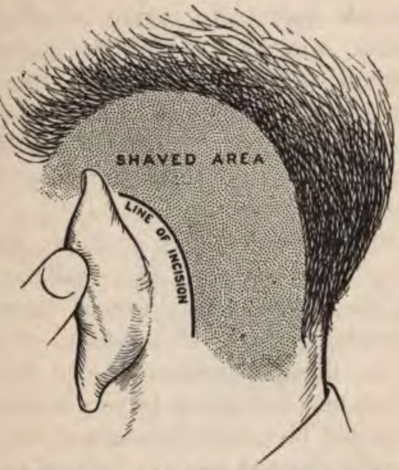


FIG. 8.—Diagram to show line of incision for Mastoid Operation.

An assistant gently pulls the auricle forward whilst an incision is made down to the bone, beginning just above the upper insertion of the pinna and extending downwards about half an inch behind the auricle in a curved direction forwards towards the tip of the mastoid process. If there is much infiltration and thickening of the soft tissues, the curvature of the incision may be increased in order to give sufficient room. If the abscess is very large and if, from the symptoms, much destruction of the bone is suspected, the incision may be made somewhat farther back, so that, if necessary, the lateral sinus can be exposed. With a periosteal elevator the soft tissues are rapidly reflected forwards and backwards, bringing into view the posterior upper margin of the bony meatus and Henle's spine in front, the zygomatic ridge above, and the fibres of the sterno-mastoid arising from the tip of the mastoid process below: the bone should be laid bare for the space of an inch behind the auditory canal.

Any bleeding points should be arrested; the drier the wound is kept, the clearer the view and the easier the operation. The edges of the wound must be kept apart by retractors held by an assistant. If an abscess is present, its lining membrane should be cut away. The periosteum may be found to be very much thickened. The bone should be carefully examined for a fistula, which is usually situated over the body of the mastoid, close behind the external auditory meatus; it may, however, be situated further back or lower down near the tip of the mastoid process. A probe or the seeker is used to explore the fistula, and to discover whither it leads. Sometimes, however, the fistula ends blindly, as if the abscess cavity in the mastoid process were not connected with the antrum. It has been previously mentioned that the approximate surface marking of the position of the antrum is the suprameatal triangle. This, however, is an uncertain guide. As the antrum lies just above and behind the tympanic cavity, the direction in which the bone should be removed to reach it, is parallel to that of the auditory canal, just behind its upper posterior part. The area of bone to be removed is about half-an-inch square, having as boundaries the zygomatic ridge above and Henle's spine in front.

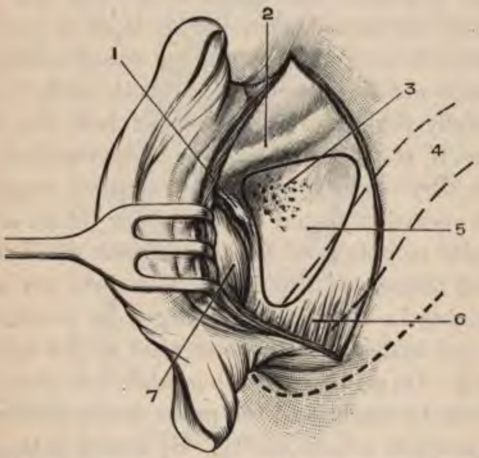


FIG. 9.—Diagram to show the surgical anatomy of Schwartze's Operation.

1. Spine of Henle.
2. Posterior root of zygoma.
3. Vascular area over body of mastoid, the usual position for a fistula.
4. Superficial marking for lateral sinus.
5. Area of bone removed in Schwartze's operation.
6. Tip of mastoid process, with fibres of sterno-mastoid muscle.
7. Fibrous portion of posteror wall of external auditory canal.

Dotted line below 6 represents outline of mastoid process.

The bone should be removed by short decided taps on the gouge which should be held in contact with the bone in a sloping direction. At first the bone is removed in a downward direction from the zygomatic ridge in order to avoid injury to the middle fossa, which may project very low. Similarly, in removing the posterior portion, the gouge is directed well forward to prevent injury of the lateral sinus, which may be situated abnormally far forward. The bone is removed in such a manner that a funnel-shaped opening is made, having its apex directed inwards, upwards, and forwards towards the aditus. Anteriorly the bone is removed as close as possible to the posterior wall of the auditory canal, which, however, must not be injured. If a fistula exists, it should be carefully probed to see if it leads into the antrum or not. If the bone is carious and granulations are present, they should be gently curetted away. The field of operation should be kept clear by an assistant repeatedly mopping out the wound with small strips of sterilized gauze. If the fistula leads into the antrum, the opening in the bone is enlarged by means of the gouge and mallet until a clear view of the antrum is obtained. On an opening being made into the antrum, pus is seen to exude, and the probe or the seeker can be felt to pass into a large cavity. By means of the seeker, its limits are made out and any over-hanging pieces of bone are removed. The antrum can be recognized by its smooth surface which has a quite different appearance to the mastoid proper. After the antrum has been opened any granulations which are present must be carefully curetted away. The wound is kept dry and, under a good light, a careful search is made for the aditus through which a bent probe may be gently passed for the sake of confirmation. The aditus is recognized as a small hole at the anterior inner part of the antrum, on the floor of which may be seen a whitish rounded eminence—the external semi-circular canal. The surrounding bone is now carefully examined; care must be taken to remove all the carious bone and any cells communicating with the antrum. Any patches of carious bone or points from which pus or granulations appear must be exposed, if necessary removing all the cells down to the tip of the mastoid process and exposing the lateral sinus or dura mater of the middle fossa. If there is disease of the posterior wall of the external meatus or of the cells extending along the root of the zygoma above the bony meatus, they also must be

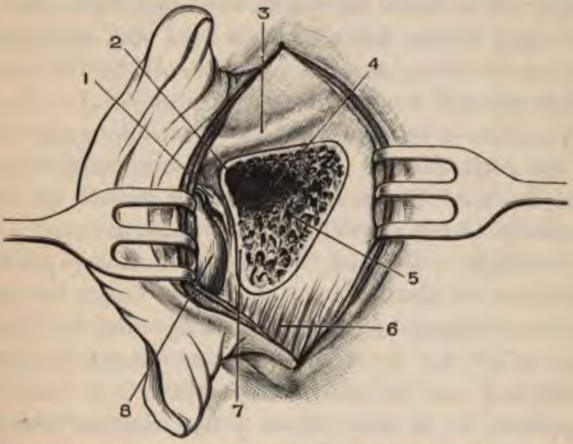


FIG. 10.—Schwartze's Operation—the simple opening of the Antrum and Mastoid.

1. Spine of Henle.
2. Aditus (in depth of wound) leading to tympanic cavity.
3. Posterior root of zygoma.
4. Antrum.
5. Mastoid cells.
6. Tip of mastoid with fibres of sterno mastoid.
7. Posterior wall of external auditory canal.
8. Fibrous portion of external auditory canal—*not* separated from the bony portion.

removed. *It does not matter how much bone is removed nor even if the greater part of the posterior upper wall of the bony meatus is removed, so long as the tympanic cavity itself is not injured, and the small ridge of bone forming the outer wall of the aditus is left intact.* It is better to remove too much bone than to leave any disease behind. As a final step any roughness of the bone may be made smooth by the use of a burr which is worked by an electric motor.

Attention is now paid to the tympanic membrane. If the perforation is small, the membrane should be freely incised. The posterior wound is flushed out with a solution of 1 in 5,000 biniodide of mercury, and some of this fluid is syringed through the aditus so that it flows out of the external meatus, in order to show that the drainage is free: in doing this, too much force must not be used. In some cases, owing to thickening of the mucous membrane, it may be impossible to at once obtain a free channel between the antrum and the external meatus. A small tube is now inserted down to the aditus and the cavity lightly packed with sterilized gauze. The upper and lower extremities of the wound may be sutured, but a free opening must be left. After drying out the auditory canal, a small strip of gauze is inserted as a drain, and the ear is protected by a dressing of sterilized gauze and wool, which is kept in place by a bandage.

In cases of *Bezold's mastoiditis* the tip of the mastoid process should be removed and the sinus leading through its inner surface into the digastric fossa should be found and its edges thoroughly curetted.

If there is a deep cervical abscess, a counter opening should be made in the neck and a tube inserted.

The mistakes to be avoided in performing the mastoid operation are described on page 233.

Opinions differ as to the amount of bone to be removed; some consider a small opening into the antrum is sufficient, but I am strongly of the opinion that it is wiser to make a large opening, and, if necessary, to remove all the cells down to the tip of the mastoid or even to expose the lateral sinus and dura mater. The only disadvantage in removing a large area of bone is that the healing may be somewhat longer delayed, but to be weighed against this are the great advantages of making certain that all the diseased bone has been removed and also that in future it is practically impossible for a recurrence of the disease to take place. If the disease seems limited to some of the cells in the mastoid process, it is advised by some authorities that they should be merely curetted away and the antrum not opened. *I consider that the antrum should always be opened, as the chief object of the operation is to allow of free drainage from the antrum.* Although in small children curetting away of the diseased bone with a Volkmann's spoon may, in come cases, lead to cure, this procedure cannot be considered a good surgical practice, as in many cases all the diseased bone is not removed, and, in consequence, permanent healing will not take place.

After treatment.—As a result of the operation, the temperature becomes normal and the pain disappears. If there is no abscess over the mastoid process, and if it is possible to remove all the diseased bone, the dressing need not be changed until the third or fourth day provided the temperature remains normal. If, however, the abscess is large and there is much infiltration of the surrounding tissues, it is wiser to change the outer dressings the next day and apply a light dressing of wet boracic lint which can be frequently changed. The superficial dressings should always be changed as soon as their outer layer becomes stained from the oozing through of blood or secretion. The pain of the dressing may be greatly diminished by gently soaking the gauze with some simple warm antiseptic lotion, the gauze being gradually withdrawn during the act of syringing; or, if the patient is very sensitive the gauze may first be soaked with 1 per cent. cocaine or eucaine solution. The cavity should be thoroughly cleansed with a 1 in 3,000 solution of biniodide of mercury, which may also be syringed through the aditus into the tympanic cavity. The wound cavity is then dried and repacked. It is usually sufficient to change the dressings every second day until about the end of the second week, when, from formation of granulation tissue, the discharge may become more free, requiring the dressing to be changed daily. If the operation has been successful and the disease has been limited to the mastoid without involvement of the attic or ossicles, the discharge from the ear itself usually ceases within two or three days. The antrum soon becomes separated from the tympanic cavity by granulation tissue. The tube may now be removed. The wound should always be carefully packed so that it heals from the bottom. As healing takes place the wound becomes more shallow and the auricle, which may at first project a little downwards and outwards gradually resumes its normal position. Healing of the wound takes place within four to eight weeks after the operation, depending on its size. The resulting scar and the slight depression behind the ear is often almost unnoticeable. The hearing again becomes normal within six weeks of the operation, sometimes much earlier.

The results of the operation are good. Continuance of the discharge from the ear is an unfavourable sign, as it is usually due to disease of the attic region. Non-healing of the wound posteriorly means that all the bone disease has not been removed. If a fistula persists, the wound must be opened up, the granulations curetted away, and any underlying bone disease removed. The continuance of the discharge from the meatus with a fistula behind the ear is an indication for the complete mastoid operation.

Complications of acute mastoid disease.—(1) The most usual complication is an *extra-dural abscess*. As this may give rise to no special symptoms, it is wiser, if the bone disease extends above towards the tegmen tympani or backwards towards the lateral sinus, to expose the dura mater and the lateral sinus rather than risk their being left surrounded by septic granulations or pus.

(2) *Meningitis* is rare. It may occur within two or three days after the onset of the disease as the result of influenza.

(3) *Septic infection of the lateral sinus and intra-cranial abscess* may occur, but are more usually seen as sequelae of chronic mastoid disease.

CHAPTER X

CHRONIC DISEASE OF THE MASTOID PROCESS

As a result of chronic middle ear suppuration changes take place in the lining mucous membrane and underlying bone of the antrum and mastoid cells.

The pathological condition depends very largely on the anatomical structure of the mastoid process. In those of denser structure there is frequently a gradual process of osteosclerosis and eburnation of the bone so that the mastoid may become of almost ivory hardness, and the antrum diminished in size. On the other hand, if the mastoid is chiefly of the diploic or pneumatic type, gradual absorption of the bone may take place as the result of caries, the cavities in the bone becoming filled up with granulations, inspissated pus, and epithelial débris. In other cases instead of caries there may be actual necrosis of portions of the bone. From the gradual absorption of the bone, fistulae may communicate anteriorly with the auditory canal through its posterior wall, externally with the skin over the region of the mastoid process or internally with the labyrinth, especially the external semicircular canal. The absorption of the bone is usually greatest in cases of cholesteatomata in which only its lining membrane may eventually separate the mastoid cavity from the dura-mater of the middle fossa above or the lateral sinus behind.

Symptoms and course.—The tympanic cavity always shows signs of chronic suppurative disease, such as granulations, polypi, fistulae, or clumps of epithelial débris protruding from the attic or antral region.

Chronic inflammation of the mastoid process may exist for years without giving rise to any serious symptoms until, perhaps, there is an acute exacerbation of the disease accompanied by all the signs and symptoms of an acute mastoid inflammation or some intracranial complication. From time to time there may be attacks of headache, a feeling of heaviness in the head, neuralgic pains, dizziness, tinnitus or an apparent bilious attack, which are the result of some temporary obstruction of the outflow of the discharge. These symptoms must be looked upon as danger signals, especially if accompanied by pyrexia. So long as free drainage exists, the temperature remains normal. The recurrence of pyrexia may mean either that there is retention of pus within the mastoid process or it may be a premonitory symptom of some intracranial complication. It is often impossible to tell from examination of the ear to what extent the mastoid process is affected, especially in cholesteatomatous formation ; the mastoid when opened by operation often shows far greater destructive change than was anticipated. If, therefore, symptoms of retention of pus occur and relief cannot be obtained by conservative treatment, operative measures become necessary, owing to the risk of septic infection extending to the intracranial cavity or lateral sinus. If the mastoid is very sclerosed there may be no external signs but merely a continuous aching pain which is increased on deep percussion. Occasionally there is slight infiltration of the soft tissues over the mastoid process as the result of periostitis. An acute inflammation of the mastoid occurring in a chronic condition is far more serious, and the symptoms are usually more severe than in a primary acute mastoiditis, owing to the greater destruction of the bone and to its septic contents.

Complications.—Apart from intracranial complications, facial paralysis, symptoms of Menière's disease from involvement of the semicircular canals, or suppuration of the internal ear may arise during the course of the disease.

Diagnosis.—(1) If there are no acute symptoms nor external signs of disease, the diagnosis depends on the history of the chronic middle ear suppuration accompanied by occasional symptoms of retention of pus, and by the presence of chronic suppurative changes in the tympanic cavity, especially granulations, polypi or fistulae in its upper posterior part.

(2) Granulations protruding through a fistula in the posterior wall of the auditory canal have to be diagnosed : (*a*) *From a simple polypus* springing from the tympanic cavity. The diagnosis can usually be made by means of a probe. (*b*) *From furuncles.* The probe has again to be used. In furunculosis the swellings are situated in the cartilaginous or fibrous portion of the meatus; they are exceedingly painful on being touched with a probe and no bare bone can be felt. Granulations springing from a fistula are more deeply situated in the bony meatus, are not very painful on probing, and

beneath them can be felt carious bone, or the probe may be passed through the fistula into the antrum or mastoid.

(3) An acute inflammation of the mastoid process occurring in the chronic condition has to be diagnosed from a primary acute mastoiditis or from furunculosis of the external meatus occurring in a chronic middle ear suppuration.

This differential diagnosis is very important as on it depends subsequent treatment.

(*a*) *In an acute mastoiditis occurring in a chronic condition.*—In addition to the objective signs of projection of the auricle from the head, infiltration of the soft tissues behind the mastoid process, pain and tenderness on pressure, there is also a history of a chronic otorrhoea and very often the significant fact that the mastoid symptoms occurred shortly after the cessation of the purulent discharge. Sometimes there is no history of a pre-existing otorrhoea, but usually close questioning reveals the fact that there was an abscess in the ear some years ago and that there has been a slight discharge, off and on, since that period, to which no attention has ever been given. On examination there are signs of old middle ear suppuration within the tympanic cavity, or there may be granulations, crusts, or masses of epithelial débris; whereas in *acute mastoiditis* the tympanic membrane will show signs of a recent acute inflammation but no signs of bone disease, and the shortness of the duration of the disease will confirm the diagnosis.

(*b*) *In furunculosis occurring in combination with chronic middle ear suppuration.*—The various points already mentioned as a means of differential diagnosis between furuncles and acute inflammation of the mastoid must be carefully considered (*see* page 197). If the perforation is a central one, and there are no actual signs of bone disease in the upper posterior quadrant, the furunculosis is probably the result of infection from the purulent discharge. In cases of doubt, it is wiser to clear up the diagnosis by operation, but if the symptoms are not urgent the furuncles may be incised and the case watched for a day or two to see if the symptoms disappear or not.

Treatment.—The treatment of chronic mastoid disease is necessarily operative, but it is assumed that before any operative measures are considered that the principles of treatment laid down for the varying pathological conditions occurring in chronic middle ear suppuration have been conscientiously carried out, and have failed.

It is difficult to lay down arbitrary indications for the "complete" mastoid operation; each case must be judged on its merits. If the symptoms are not urgent every endeavour should be made to cure the case by conservative measures or ossiculectomy, as by these means sometimes the most successful results are obtained even in cases of long-standing otorrhoea.

The following are **the chief indications for performing the complete mastoid operation:—**

1. *As a prophylactic measure.* In a case of chronic middle ear suppuration if there are no urgent symptoms and if, on examination of the tympanic cavity, there is no

evidence of bone disease it becomes a difficult matter to decide whether the mastoid operation should be advised or not.

If the otorrhoea has continued for over a year in spite of *careful* conservative treatment, the question of operation may be considered in order to obviate the risk of any future intracranial complications. The appearance of the tympanic cavity is not always an indication of the changes which have taken place in the mastoid process, for although in the majority of cases extensive caries of the mastoid or cholesteatomatous formation is shown by the presence of granulations, evil smelling discharge and epithelial débris, yet it occasionally happens that symptoms of intracranial disease may suddenly occur and the resulting operation may show extensive disease of the mastoid process in a patient in which examination of the ear only shows a large perforation with congestion of the mucous membrane of the tympanic cavity. If the perforation is central and if the hearing is fair, that is if conversation is heard farther off than 12 feet, the persistence of the otorrhoea may be due to a chronic empyema of the antrum ; if so, the simple Schwartze's operation will be sufficient to bring about a cure. If, however, in addition to the changes due to the suppurative process, the deafness is extreme, the bone conduction is diminished and the high tuning-forks not well heard, or if the ossicles are bound down by adhesions to the inner wall of the tympanic cavity, the complete mastoid operation may be advised. In the former case owing to the internal ear being already affected the hearing will not be improved, in the latter, owing to the adhesions, there is no object in not doing the complete mastoid operation, as the only reason for attempting a cure by Schwartze's operation is to preserve the ossicles in the hope of obtaining restoration of hearing. It must be remembered, however, that in many cases, a slight discharge may exist for years without any complications occurring.

Ceteris paribus operation is the more necessary if the patient is going to some country where efficient medical treatment is unable to be obtained.

2. If there is repeated *recurrence of polypi and granulations*, especially in the upper posterior quadrant, in spite of conservative treatment, or the operation of ossiculectomy having been performed.

3. If there are *recurrent attacks of giddiness, a feeling of nausea, or headaches* radiating up the affected side which are not arrested by the ordinary methods of treatment. These are symptoms of retention of pus within the antrum and mastoid and may be looked upon as danger signals.

4. If there is obstruction to free drainage of the discharge in a chronic middle ear suppuration, the result of *stenosis of the external meatus*, giving rise, from time to time, to symptoms of retention of pus.

5. When a diagnosis of *cholesteatomatous formation* has been made, even if there are no immediate symptoms necessitating operation. Experience has shown that intracranial complications or septic thrombosis of the lateral sinus occur more frequently as the result of this condition than any other.

6. *Fistulae* of the bony walls of the mastoid process whether extending anteriorly into the auditory canal, or externally through the skin behind the mastoid

process, or inferiorly into the neck tissues, are an indication for operation in that they show obvious signs of carious bone.

7. *Facial paralysis* occurring in a chronic otorrhoea may mean either that there is bone disease around the facial canal, or that the inflammatory process has spread through the Fallopian canal towards the inner ear. In either case operation is indicated (*see* p. 234).

8. *Intracranial suppurative lesions.* As the origin of intracranial disease lies in the middle ear or mastoid process the complete mastoid operation should first be performed in order to remove the primary cause. Otitic intracranial lesions always spread by contiguity from the primary focus. By first performing the complete mastoid operation, it is often possible, in difficult cases, to tell where the abscess will be situated by tracing back a carious patch of bone.

9. *In tuberculosis* of the middle ear. If the patient's general condition permits of it, and the pulmonary disease is slight or arrested, the complete operation should always be done. The difficulty is to remove all the diseased bone. If this can be done, the case will heal quite well.

10. *In acute mastoid disease occurring in the course of chronic middle ear suppuration*, the complete mastoid operation should be performed as in these cases there is invariably bone disease about the region of the attic, aditus and antrum.

The complete or "radical" operation was not adopted as a surgical procedure until as recently as 1889. In that year Küster proposed, in addition to performing Schwartze's operation, to remove the posterior wall of the auditory canal to allow of better drainage. Bergmann then suggested removal of the outer attic wall, and Zaufal combined both operations. The object of the complete mastoid operation is to convert into one large cavity the tympanum, attic, antrum and mastoid process; in Schwartze's operation the tympanum and ossicles are not interfered with. The complete operation is only performed when it is certain that there is, in addition to disease of the mastoid process, also disease of the walls of the attic and of the ossicles themselves.

Technique of the operation.—First stage.—The incision is made and the antrum is opened in the manner already described in Schwartze's operation. The soft tissues, however, may be separated a little further above and in front of the external bony meatus, as in this operation the upper posterior wall has to be removed.

Second stage.—The fibrous portion of the external meatus is now carefully separated by means of a periosteal elevator from the posterior wall of the bony meatus and is pulled forward by means of a small retractor so that two openings are now seen, one in front—the auditory canal, and the other behind—the opening into the antrum. Between the two is the posterior wall of the auditory canal, which is now removed. For this purpose the chisel is more suitable than the gouge. The outer part of the posterior wall is removed in the form of a wedge by chiselling from above downwards and from below upwards. A Spencer-Wells forceps is passed into the auditory meatus, the point of the forceps projecting through the end of the fibrous portion of the canal which has been separated from the bony wall. A piece of gauze is drawn through the canal so that the auricle and fibrous portion of the auditory meatus are pulled well forward, exposing to view the tympanic cavity. Any granulations are now curetted out and the parts rendered as dry as possible by careful mopping.

Third stage.—The seeker is passed into the tympanic cavity and its point directed upwards and backwards into the aditus. As it lies in this position, its point will rest on the floor of the aditus, lying on the external semicircular canal, beneath which is the facial nerve. All the bone lying superficial to this point can be safely removed without injury to the facial nerve. Instead of the seeker, Stacke's probe is sometimes used, but this is a large and clumsy instrument and by careless or rough usage it may itself cause injury to the facial nerve. If the operator is inexperienced it is wiser to leave the seeker in position as a guide to the amount of bone to be removed. The remains of the posterior wall, that is the so-called "bridge" between the antrum and tympanic cavity, is now removed in small portions. It must not be forgotten that the roof of the antrum, aditus and attic is a continuous one. Therefore the bone to be removed is at a higher level than the roof of the bony meatus. *It is better to remove the bone too high up and expose the middle fossa than to go too low down and injure the facial nerve.* In removing the lower portion the stroke should be begun close to the tip of the mastoid process and directed parallel to the auditory canal just superficial to the level of the seeker. In this way the operator is bound to keep superficial to the semicircular canal and, as he works parallel with the direction of the facial nerve which passes beneath the semicircular canal to run more deeply towards the stylo-mastoid foramen, he runs very little risk of injuring it. During removal of the bridge of bone, the operator should frequently make use of the seeker to remind him of his landmarks. As the aditus is approached, the strokes with the chisel must be very gentle; if too much force is used on removing the innermost portion of the bridge, the chisel may injure the semicircular canal with the facial nerve beneath it.

Fourth stage.—The ossicles, if still present, are now removed. The overhanging edge of the outer wall of the attic, which can be felt with the seeker, is also removed by gentle taps with a small gouge. Any projections of bone should be smoothed off by means of an electric burr or by the gouge and chisel. It is desirable to make the surface of the cavity as smooth as possible, in order to promote healing and render the after dressings less painful to the patient. Finally with a small curette the recesses of the tympanic cavity are carefully curetted out, but care must be taken not to injure the surface of the promontory nor the regions of the fenestra ovalis nor the fenestra rotunda. It is especially important to curette away the mucous membrane around the orifice of the Eustachian tube in order that scar tissue may obliterate its lumen and prevent re-infection of the middle ear from the naso-pharynx. Moreover, if the Eustachian tube remains patent, the epidermization of the tympanic cavity may be delayed or prevented, and in such cases there may, from time to time, be a mucoid or muco-purulent discharge from the persisting mucous membrane. When the operation is completed, the cavity, although irregular in outline, should be of smooth surface and only a slightly projecting ridge (the remains of the posterior wall of the bony meatus), having at its innermost extremity the semicircular canal, should separate the mastoid process from the tympanic cavity and auditory canal.

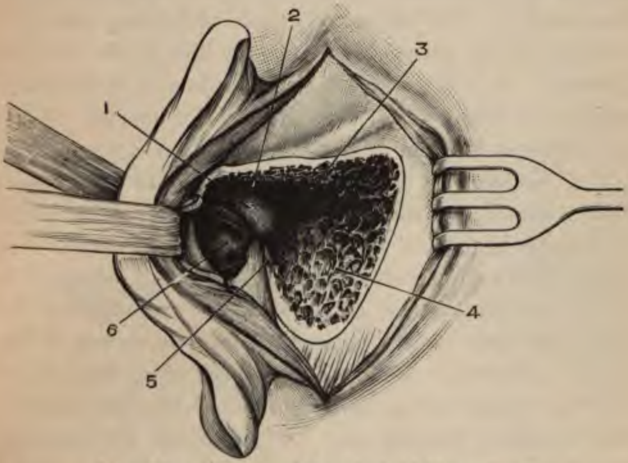


FIG. 11.—The complete Mastoid Operation.

1. Semicircular canal.
2. Attic and tegmen tympani.
3. Antrum.
4. Mastoid cells.
5. Ridge of bone (remains of posterior wall of external meatus) between the mastoid and tympanic cavities.
6. Inner wall of tympanic cavity.

The fifth stage is to make the posterior meatal skin flap. The loop of gauze with which the assistant has held forward the ear is removed. A long narrow curved bistoury is passed down the external meatus so that it projects with its point directed backwards. The auricle is held well forward and the fibrous portion of the meatus is cut through posteriorly, from within outwards, for a short distance. The edge of the bistoury is then directed upwards and the incision continued in a slanting direction outwards as far as the cartilaginous portion of the meatus, care being taken not to cut into the concha. The bistoury is then withdrawn and re-inserted at the point where it was first made to turn upwards; it is now turned downwards and in a similar manner is directed towards the inferior margin of the cartilaginous meatus. The fibrous portion of the meatus is thus divided by a Y-shaped incision into three small flaps; namely a posterior V-shaped flap which is turned backwards and fixed to the skin behind the auricle by means of a catgut suture, and an upper and inferior flap which are pressed upwards and downwards against the roof and floor of the mastoid cavity by means of the finger. (Fig. 12.) The object of the skin flaps is to aid the growth of the epithelium over the raw surface. The opening behind the ear is closed by suturing together the edges of the skin incision. The cavity of the wound is packed through the meatal opening. A dressing of sterilized gauze and wool is now applied and kept in position by means of a bandage.

After treatment.—The patient should be kept in bed for the first few days. The ear need not be dressed until the fifth or sixth day. After removing the gauze plug, the wound should be gently syringed out with a mild antiseptic solution, such as a drachm of lysol to a pint of warm water, and afterwards carefully dried and repacked with a strip of sterilized gauze. The posterior wound heals by primary union and the stitches may be removed on the eighth day. After the first dressing, the ear should be dressed every second day until the end of the second week, when the formation of granulations may cause an increased amount of purulent discharge necessitating daily dressing. If the secretion is slight and not offensive, syringing out of the ear with a very mild antiseptic solution or normal saline solution is sufficient. When the discharge is profuse and offensive, after removing the gauze, the wound cavity should be washed out with a solution of 1 in 3,000 biniodide of mercury before repacking. Also an ear bath of a solution of hydrogen peroxide, before the ear is syringed out, is often of great benefit. The wound surface, which can be inspected by the

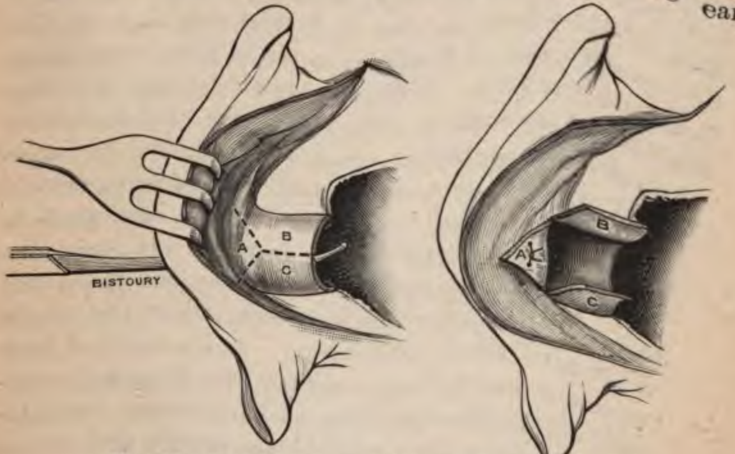


FIG. 12.—To show post-meatal Skin Flaps.

A Posterior flap. *B* Superior flap. *C* Inferior flap.

insertion of a large aural speculum into the external meatus, is found to become gradually covered with granulations. The last part of the bone to be covered is the region of the semicircular canal and the remains of the posterior wall of the external meatus. If the blood supply is not great, as in cases of sclerosis of the bone, the granulations take longer to appear. When the bone is cancellous, granulations may be abundant. The chief object in the after treatment is to prevent the overgrowth of granulation tissue, so that the epithelium can grow in from the borders of the skin flaps and cover the wound area. Under the local anaesthetic of cocaine, excessive granulations should be either curetted away or touched with trichloracetic acid or chromic acid fused on a probe. Great care must be taken that the epithelium grows evenly over the surface of the wound cavity. Adhesions, the result of granulations, are liable to occur about the region of the attic, aditus and antrum. As the result of these adhesions, free drainage may not take place, and afterwards further disease of the bone may occur. Granulations recurring after removal are usually due to the persistence of a small patch of carious bone, and healing will not take place until the fragment of bone comes away or is removed. The discharge usually diminishes about the sixth week. About this period the gauze plugging can usually be discontinued and in its place, after syringing out and drying the ear, drops of rectified spirit lotion containing 10 grains of boric acid to the ounce may be given. Occasionally, in the later stages of after treatment, healing is more rapid under a dry method of treatment; that is, after syringing out and carefully drying the ear, some boric acid powder is insufflated into the meatus and is only removed when the ear again becomes moist. Aristol or orthoform may be used if boric acid powder causes irritation. The duration of the after treatment depends largely on the extent of the disease and on the resulting wound cavity. As a general rule, healing of the wound is complete within three months after the operation, but in some cases, especially in young healthy patients in whom the disease is limited, healing takes place within eight weeks. If, however, in addition to disease of the mastoid there is caries of the promontory or floor of the tympanic cavity or about the orifice of the Eustachian tube, although epidermization of the mastoid process may take place, granulations may repeatedly recur within the tympanic cavity causing the continuance of a slight purulent discharge. These granulations should be carefully removed as they recur.

Under the following circumstances the posterior wound incision should be left open, so that the wound cavity may be packed from behind as well as in front :—

1. If there is an abscess over the mastoid process. Although in some of these cases (provided the walls of the abscess cavity have been excised), primary union may take place, it is wiser, for the first few days, to pack the wound from behind as well as through the external meatus. On the appearance of healthy granulations, the edges of the wound can be brought together by silkworm sutures. This procedure is not painful, but in nervous patients a general anaesthetic of gas and oxygen may be given.

2. If there is extensive disease of the bone, and the dura mater and lateral sinus are found covered with septic granulations.

3. When there is bone disease of the anterior and inferior part of the tympanic cavity.

By leaving the posterior wound open for a few days, the after treatment of packing or, if necessary, the curetting away of granulations can be more easily carried out than through the external meatus.

Modifications of the mastoid operation.—1. *Stacke's operation.*—In a certain number of cases when there is marked sclerosis of the mastoid process or if the lateral sinus projects far forwards and the middle fossa downwards, there may be difficulty in finding or reaching the antrum by the ordinary methods. In such conditions, Stacke proposed exposing the antrum from within outwards. In this operation, after making the post-aural incision, the soft tissues are reflected forwards and the fibrous portion of the meatus is separated from the bony portion until a probe can be inserted upwards and backwards into the aditus. With a small gouge pieces of bone are carefully removed from the upper posterior margin of the attic and aditus until the antrum is freely exposed. When this has been done, as much bone of the mastoid process as is necessary can be chiselled away either by extension backwards from the antrum or by the method previously described. Stacke originally devised this method for those cases in which he thought the bone disease was limited to the region of the attic, aditus and antrum.

2. *Leaving behind the ossicles and membrane after performing the complete mastoid operation.*—This opera-

tion is well-known and has been performed for years. I have in my collection a specimen which I prepared in 1900 after seeing Jansen of Berlin do this operation. I mention this fact because recently this modification of the mastoid operation has been reintroduced under the claim that it is a new operation, and that it has exceptional advantages with regard to rapid cure and restoration of hearing. Retention of the membrane and ossicles can only be of service if there is no disease of these bones nor of the attic region. If such is the case, it should not be necessary to do the complete mastoid operation; Schwartze's operation should be sufficient. If, on the other hand, there is disease of the ossicles and attic region, there is no object in leaving them, as either the disease will progress or, if it becomes arrested, post-suppurative adhesions will bind down the ossicles causing probably a greater deafness than if the ossicles had originally been removed. The results of such operations cannot be judged until at least a year after their performance nor can they be based on the experience of a few cases.

Skin-Grafting.—In order to shorten the course of healing, endeavours have been made to introduce Thiersch's skin grafts into the wound. This method was first introduced by Siebenmann in 1893, who advised transplanting small pieces of skin taken from the arm or leg into the wound cavity, two or three weeks after the operation. Charles Ballance in 1900 re-introduced this method, but instead of transplanting two or three pieces of skin, filled the cavity with one large graft. If skin-grafting is adopted, the post-aural incision is re-opened about the tenth day. The

the exact proportion of cures, but roughly speaking it may be said that at least 80 per cent. are cured.

2. *With regard to hearing.*—Provided there is no internal ear deafness, the hearing power after a successful mastoid operation should not be worse than after removal of the ossicles in a simple ossiculectomy. The amount of hearing depends on the condition of the inner wall of the tympanic cavity. The best hearing is obtained in those cases in which the region of the stapes and fenestra rotunda has not been interfered with. If, as the result of violent curetting, adhesions form in these regions, especially if the stapes becomes bound down to the margins of the fenestra ovalis, the deafness may be extreme. Similarly if from lack of careful after-treatment granulations are allowed to spring up and form a large pad covering the inner surface of the tympanic cavity, the resulting solid fibrous wall may produce a condition of almost complete deafness. After a successful operation, the average hearing power is a distance of at least 12 feet .for ordinary conversation and 6–8 feet for whispering. In some cases, however, the hearing may be extraordinarily good, and whispering may be heard even at a distance of 20 feet.

I recently showed at the Otological Society a patient in whom whispering could be heard over a distance of 20 feet, in spite of the complete mastoid operation and removal of the malleus, incus and *stapes*: there was indeed almost complete restoration of hearing.

If, before operation, there is evidence of internal ear deafness, the patient should be told that the operation cannot in any way improve the hearing. If, however, the deafness is of the middle ear type and is extreme owing to the tympanic cavity being filled with granulations and polypi, the surgeon may reasonably assume that the hearing will be improved as the result of the operation.

The difficulties and dangers of the mastoid operation.—The chief dangers are injury to the facial nerve, the semicircular canal, the dura-mater of the middle fossa and the lateral sinus.

(1) *Injury to the facial nerve.*—The usual point at which the facial nerve is injured is either in the upper posterior wall of the tympanic cavity just before it passes beneath the external semicircular canal, or lower down as it passes through the mastoid process towards the stylo-mastoid foramen. It may be injured by too violent curetting of the tympanic cavity, or by too forcible chiselling through the bridge of bone covering the aditus. *In performing the mastoid operation there is a tendency for the inexperienced operator to work too low down and to get below the level of the antrum,* especially if it be a small one. The antrum is not then discovered, and the bone is chiselled away too deeply until a sudden spasm of the face shows that the facial nerve has been injured. To avoid this injury, if the antrum cannot be discovered after chiselling through the bone to the depth at which the antrum is expected to be found, it is wiser to work at a higher level, even exposing the dura-mater if necessary, or else to expose the antrum according to the method of Stacke.

(2) *The external semicircular canal* is similarly injured from the bone being removed too low down. As a

result of this injury nothing may happen, but often there is giddiness and vomiting which may last for a considerable time after the operation, and in addition there is a possibility of septic infection of the labyrinth.

(3) *Injury to the dura-mater of the middle fossa.*—By carefully chiselling in a slanting direction downwards this should not occur. There is no harm in exposing the dura-mater, provided it is not cut through. If it is injured, a little of the bone should be removed round the injured area, which is then carefully cleansed with a strong antiseptic solution and covered with iodoform powder. It is extremely rare for meningitis to occur.

(4) *Injury to the lateral sinus* is also of rare occurrence. It is also best avoided by chiselling in a slanting direction forward. If the sinus wall is inadvertently cut through, sufficient bone should be removed so that a plug of gauze may be applied to the surface of the sinus in order to arrest the haemorrhage. The operation can usually be proceeded with, but after packing the cavity the posterior wound should be left open, and the gauze which has been applied to the sinus wall should not be removed for at least two days. Its removal should be done gently after soaking it with some mild antiseptic lotion. If haemorrhage recurs, a fresh piece of gauze should be re-applied and left in position for three or four days.

PARALYSIS OF THE FACIAL NERVE.—Paresis or paralysis of the facial nerve may occur in the course of any inflammatory disease of the middle or internal ear, nor is this surprising considering its anatomical course.

It is impossible to discuss here all the causes of facial paralysis, but only so far as it is associated with diseases of the ear.

1. Facial paralysis may occur in cases in which there is no obvious disease of the ear. There is, however, often a history of the patient having been exposed to a draught, and as a result of this there may be a "stiff neck." These cases are sometimes described as rheumatic, but are probably due to some inflammatory thickening around the stylo-mastoid foramen causing pressure on the nerve. In other cases the paralysis may be due to pressure produced by enlargement of the lymphatic glands.

2. In middle ear catarrh with exudation, in acute otitis media, and in acute middle ear suppuration, the paralysis is probably due to the swollen mucous membrane or exudation causing pressure on the nerve, or from a perineuritis or neuritis from extension inwards of the acute inflammatory process along the nerve. In these cases there may be a deficiency in the bony wall of the Fallopian canal.

3. In chronic middle ear suppuration, an additional cause is caries or necrosis of the walls of the facial canal.

4. In tuberculous disease, the nerve itself is often completely destroyed by the tuberculous process.

5. Facial paralysis is very common in acute suppuration or necrosis of the labyrinth.

6. It may also occur as the result of a gumma or tumour causing pressure at the internal meatus.

7. It is occasionally secondary to an extension of a purulent inflammation of the meninges along the internal auditory meatus; also as the result of a cerebral

abscess causing pressure on the nerve within the intracranial cavity.

8. It may be due to a fracture of the base of the skull and middle fossa causing direct injury to the nerve, or haemorrhage within its sheath, or from pressure from the after-formation of callus.

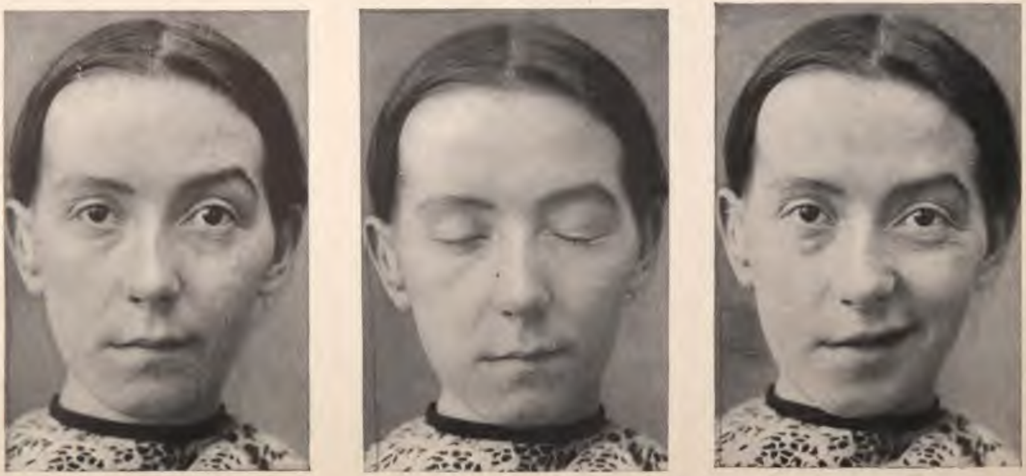
9. It may occur as a result of injury during the mastoid operation.

The **Diagnosis** is based on the condition found. In all cases of facial paralysis a careful examination should be made of the ear to see if there is any sign of middle or internal ear disease. Examination with tuning forks will show whether the middle or internal ear or both are involved. If there are no objective signs of ear disease and if the hearing and tuning-fork tests are normal, it may reasonably be concluded that the origin of the trouble does not lie within the ear. If, however, there is disease of the ear, the question arises whether it is merely coincident with or the cause of the paralysis. When otitic in origin the paralysis is always of the peripheral type.

The occurrence of facial paralysis is sometimes of diagnostic importance.

In middle ear suppuration it may be due to involvement of the nerve in the tympanic cavity or in its course through the labyrinth. In middle ear suppuration if the deafness becomes rapidly worse and is accompanied by pyrexia, attacks of giddiness, and vomiting and deep-seated pain, and if tuning-fork tests show absence of bone conduction and loss of hearing power for the high tuning-forks, acute suppuration of the labyrinth may be diagnosed.

If an intracranial abscess is suspected as the result of



Position of rest. Eyes closed. Smiling.

Incomplete Facial Paralysis of Right Side, in a case of Acute Middle Ear Suppuration—now cured.

[*Plate XVII.*

middle ear suppuration, the onset of facial paralysis will be in favour of it being situated in the cerebellum.

Symptoms.—The symptoms of facial paralysis are too well known to require description. When of otitic origin the paralysis is often slight or incomplete. Before its onset there may be intense pain of a neuralgic character radiating along the branches of the nerve. This is frequently seen when the paralysis occurs a few days after an operation, possibly due to pressure from effusion of blood into the Fallopian canal or from packing of the wound with gauze.

The position of the lesion can sometimes be fairly accurately diagnosed from the clinical symptoms. If situated between the stylo-mastoid foramen and the region of the stapedius muscle, owing to involvement of the chorda tympani nerve, there is disturbance of taste and diminished secretion of saliva on the affected side. When situated between the origin of the nerve to the stapedius muscle and the geniculate ganglion, in addition to the above symptoms there may be tinnitus, slight deafness, and increased acuteness of hearing for the low pitched notes: these symptoms are supposed to be due to paralysis of the stapedius muscle. When the lesion is more centrally placed than the geniculate ganglion there is no longer disturbance of taste owing to the chorda tympani nerve leaving the geniculate ganglion by the superficial petrosal nerve to join the fifth nerve.

The Treatment depends on the cause. If there is no middle ear disease and the cause is presumably due to some inflammation about the stylo-mastoid foramen, the side of the head should be protected with a pad of cotton wool, a blister applied just in front of the apex of the mastoid process, and sodium salicylate or aspirin (if there is much neuralgic pain) may be given in doses suitable to the age of the patient.

In slight middle ear catarrh it is sufficient to treat the aural condition. If there be much exudation of fluid within the tympanic cavity, and more especially in acute middle ear suppuration, it is essential to allow escape of the fluid by an early and free paracentesis of the tympanic membrane.

In chronic middle ear suppuration, the complete mastoid operation is indicated and in these cases the bone should be removed until the facial nerve is exposed. If, from clinical symptoms, internal ear suppuration has been diagnosed, it may be necessary to freely open the labyrinth (*see* p. 283).

The onset of facial paralysis, with a rapid increasing deafness of the internal ear type (that is involvement of the eighth nerve), occurring in cases in which there are no signs of middle ear disease, is suspicious of syphilis and in cases of doubt large doses of potassium iodide should be given in the hope that the lesion is due to the pressure of a gumma in the region of the internal meatus.

In addition to ordinary treatment it is advisable to keep up the nutrition of the facial muscles by means of galvanism.

If the symptoms point to intracranial origin and if there is a history of chronic otorrhoea the complete mastoid operation should be performed, and, unless contra-indicated, the cerebellum should be explored.

In some cases, especially if the paralysis is the result of operations on the ear and mastoid process, it has been advised, if the ordinary methods of treatment fail, to unite the peripheral portion of the facial nerve, as it escapes from the stylo-mastoid foramen, to either the spinal accessory or the hypoglossal nerve. The results of this operation have been more or less satisfactory in a few cases.

Prognosis.—When due to middle ear catarrh or acute middle ear suppuration, provided free drainage is obtained, recovery is practically certain. If the result of chronic suppuration recovery depends on how long the condition has existed before the patient comes under observation. The condition of the nerve is tested by means of the faradic and galvanic currents. If there is reaction of degeneration it means that the injury is grave and the recovery is doubtful and will, at any rate, not occur for a long period.

In tuberculous disease, facial paralysis is usually permanent.

When due to injury, the result of operation, the prognosis depends on the injury. If the paralysis occurs at once and is due to actual cutting through of the nerve by means of the chisel, unless the nerve can at once be exposed and its ends brought into contact recovery is very doubtful. Even in these cases, however, unless the nerve is completely destroyed, partial recovery may take place, although usually very slowly, perhaps not for months afterwards. If paralysis occurs after the operation, it is due to inflammatory changes, and, except in very rare cases, complete recovery occurs. The earlier the paralysis and the more complete it is, the longer is the period of recovery.

CHAPTER XI

INTRACRANIAL DISEASE OF OTITIC ORIGIN

It is now well recognized that the majority of intracranial suppurative lesions are due to direct extension of pyogenic infection from the middle ear.

They occur most frequently in the course of a long-standing and neglected middle ear suppuration, especially if cholesteatomatous formation is present, and only rarely as a complication of acute middle ear suppuration.

As might be inferred—the site of the intracranial lesion largely depends on the direction in which the bone disease extends towards the cavity of the skull.

The usual paths by which infection takes place are :—

1. *Upwards,* from caries of the tegmen tympani, or from direct extension of the infection through the petro-squamous fissure or along the petro-squamous sinus, giving rise to a temporo-sphenoidal abscess, an extradural abscess or meningitis of the middle fossa of the intracranial cavity.

2. *Downwards,* as a result of caries of the floor of the tympanic cavity, causing thrombosis of the bulb of the jugular vein.

3. *Backwards,* through the mastoid cells, giving rise to an extradural abscess, lateral sinus thrombosis, or cerebellar abscess.

4. *Inwards*, involving the inner wall of the antrum, the petrous portion of the temporal bone, or the external semicircular canal resulting perhaps in labyrinthine suppuration, meningitis of the posterior intracranial fossa, or a cerebellar abscess at its antero-inferior part.

With regard to the frequency with which these complications occur, an extradural abscess is the most common; next in order is lateral sinus thrombosis, and then intracranial abscess. Meningitis of otitic origin is rare, except when secondary to some other intracranial suppurative lesion. Intracranial abscess

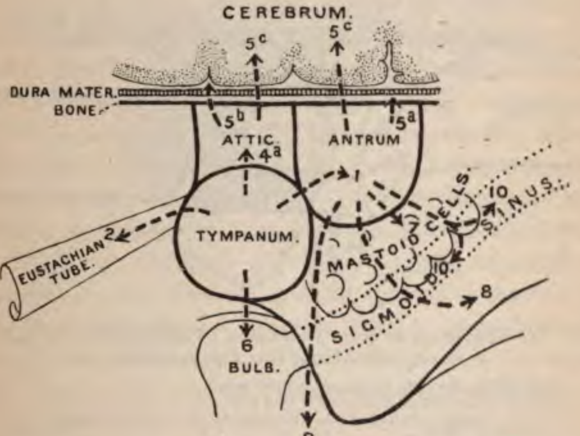


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FIG. 13.—Diagram to show extension of disease from tympanic cavity, in Middle Ear Suppuration.

1. Antrum.
2. Eustachian tube.
4*a*. Attic.
5*a*. Extradural abscess.
5*b*. Meningitis.
5*c*. Temporo-sphenoidal abscess.
6. Bulb of jugular vein.
7. Mastoid cells .
8. Fistula through cortex of mastoid.
9. Bezold's mastoiditis.
10. Lateral sinus.

and lateral sinus thrombosis are uncommon in children, being most frequently found between the ages of ten and thirty. In children temporo-sphenoidal abscess is four times as frequent as cerebellar; in adults it is twice as frequent.

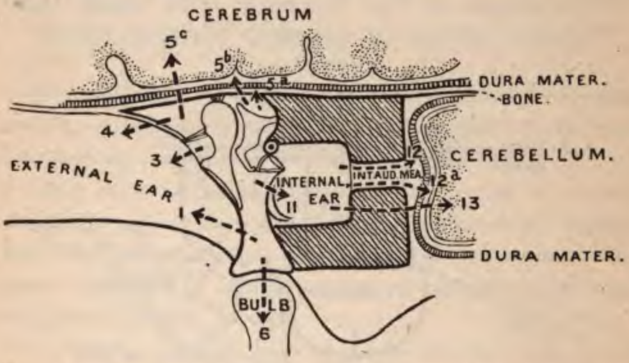


Fig. 14.—Diagram to show extension of disease from tympanic cavity, in Middle Ear Suppuration.

1. Perforation through tympanic membrane.
3. Perforation through Shrapnell's membrane.
4. Fistula through outer wall of attic (roof of external meatus).
5*a*. Extradural abscess.
5*b*. Meningitis.
5*c*. Temporo-sphenoidal abscess.
6. Bulb of jugular (thrombosis).
11. Internal ear.
12, 12*a*, 13. Route of infection through internal ear giving rise to extradural abscess, meningitis, and cerebellar abscess.

EXTRADURAL ABSCESS.—Extradural abscess occurs more often as a complication of acute than of chronic suppuration of the middle ear and mastoid process, especially if the primary cause is influenza.

Its usual situations are in the sigmoid groove surrounding the lateral sinus, or in the middle fossa above the tegmen tympani. Occasionally, as the result of internal ear suppuration, it may be localized to the posterior surface of the petrous bone.

Symptoms.—Sometimes there are no symptoms, so that the abscess is only discovered at the time of operation, whilst exposing the sinus wall or dura-mater. The temperature may be normal or there may be slight pyrexia. One of the most constant symptoms is the persistence of headache, which may be extremely severe, and be localized to the affected side. With this there is frequently tenderness on pressure *above* the ear, or *behind* the mastoid process. Suggestive also of extradural abscess is a *very* profuse discharge from the ear, which apparently is too copious to come from the tympanic cavity or mastoid antrum. If an extradural abscess, situated in the middle fossa, becomes very large, it may (especially in children) give rise to signs of cerebral irritation or compression, such as spasms or paresis of the extremities of the opposite side or to aphasia if the left side is involved; if situated in the posterior fossa, there may be retraction and stiffness of the neck.

Treatment.—It is necessary to drain the abscess. The mastoid antrum is opened according to Schwartze's method. The complete mastoid operation is only indicated if the acute inflammatory process has occurred in the course of a chronic middle ear suppuration. After the antrum and mastoid cells have been freely opened it is only necessary to chisel upwards until the middle fossa is exposed, or backwards until the wall of the lateral sinus is laid bare. If an extradural abscess exists, pus will pour out in greater or lesser quantity, and the surface of the dura-mater or lateral sinus may be found to be covered with granulations. The cavity should be well washed out with a solution of biniodide of mercury and afterwards gently packed with sterilized gauze. Provided there is free drainage and no other intracranial complication, recovery should be as rapid as in the case of simple inflammation of the mastoid process.

Owing to an extradural abscess being so frequently a complication of acute inflammation of the mastoid process, Lane, and Jansen of Berlin, have suggested that in all such cases the dura-mater and the lateral sinus should be exposed. When there is any doubt this practice is a good one, as it is wiser to expose these structures, especially as there is no danger in so doing, than risk missing the abscess.

Terminations of extradural abscess if no operation is performed.—(1) In rare cases the abscess may drain into the middle ear and the case end in complete recovery.

(2) As a rule lateral sinus thrombosis occurs as a sequela of an abscess round the sinus or

(3) Meningitis, ulceration of the surface of the brain, or an intracranial abscess may result from extension of the infection through the dura-mater.

MENINGITIS.—Except when occurring as the result of some acute virulent infection such as influenza or scarlet fever, meningitis is fortunately a comparatively rare complication of middle ear suppuration. It is usually a sequela of some other intracranial suppurative lesion.

A diffuse lepto-meningitis is almost always fatal; but there are records of a few cases of localized meningitis having been cured by operation. It is well known that in children, and infants especially, all the classical symptoms of meningitis may be present, and that complete recovery may take place after a simple paracentesis of the membrane. In such cases, however, the symptoms are not really due to a purulent meningitis, but to cerebral irritation, the result of vascular congestion; this is not difficult to understand, owing to the free communication which exists between the vessels of the middle ear and middle fossa of the skull in the first years of life.

Meningitis serosa (*serous meningitis*) is probably due to similar causes. It is associated with extradural or intracranial abscess, and sinus thrombosis. The pathological changes found in this condition are said to be a serous infiltration of the pia mater, and an increase of the cerebro-spinal fluid in the sub-arachnoid spaces and the ventricles of the brain. These changes presumably are due to congestion of the intracranial vessels, but not to true bacterial infection. After the primary cause has been removed, the congestion may diminish and the symptoms subside, the case ending in complete recovery.

Symptoms. — The chief symptoms suspicious of the onset of meningitis in middle ear suppuration are extreme restlessness, mental irritability, an irregular pyrexia, and headaches which gradually become more severe until they are almost unbearable. The onset may be sudden or insidious, depending on the virulence and extent of the infection. The early symptoms are those of cerebral irritation; the later ones, of gradual cerebral paralysis. At first there may be vomiting, attacks of vertigo, and rigidity of the neck muscles. If the meningitis extends upwards along the convex surface of the brain there may be spasms or twitchings of the extremities; if limited to the posterior fossa there is usually very marked retraction of the neck. With this there is often marked hyperaesthesia of the skin, or there may be definite pain on movement of the limbs. In the earlier stages there are photophobia and contraction of the pupils, but as the symptoms of compression develop, the pupils react more sluggishly and gradually become dilated or fixed. Strabismus, ptosis, nystagmus, or conjugate deviation may also occur. If the course of the disease is very rapid there may be no changes in the fundus of either eye, but if slowly progressive there may be optic neuritis. As the disease progresses there is increasing drowsiness, the patient lying curled up in bed, and any movement of the body, especially of the head and neck, seems painful and is resisted. The headaches may become so severe that the patient cries out with pain; and these attacks of screaming, so characteristic of meningitis, may continue after the patient has become partially unconscious. The pulse varies; in the early stage it is rapid, in the stage of compression slower, and in the later stage again rapid and irregular. In the final stages there is complete unconsciousness frequently accompanied by paralysis of the extremities, and of the bladder and rectum. The course of the disease is very variable; at one time extremely rapid, at another so slow and remittent in character as to give hope of recovery.

Diagnosis.—The diagnosis is made from the symptoms already given. It has to be distinguished from tubercular meningitis, cerebro-spinal meningitis; and from other intracranial complications (*see* p. 264).

Lumbar puncture is sometimes an aid to diagnosis. In purulent meningitis without adhesions the fluid will be purulent, but a clear fluid does not necessarily negative a purulent meningitis. In cerebro-spinal meningitis the diplococcus intracellularis may be found. In tuberculous meningitis the fluid is clear and shows many leucocytes, and perhaps tubercle bacilli.

Treatment.—The only hope of recovery lies in operative treatment. Whenever symptoms of meningitis occur the ears should be examined. A bulging membrane should be freely incised; sometimes this may give immediate relief. If the symptoms continue, the mastoid operation should be performed and the dura-mater exposed. If the dura-mater is found to be congested and bulging it should be incised. The bone and dura-mater over the diseased area should be freely removed. After washing away the secretion with a stream of sterilized saline solution, the wound area should be gently packed with sterilized gauze and the post-aural wound left open.

When it is obvious that it is too late to operate, palliative measures should be adopted, and opium or subcutaneous injections of morphia given to relieve pain. An ice bag may be applied to the head, and inunctions of mercury, or the giving of calomel may be tried. If meningitis occurs as a sequela to other intracranial complications, the prognosis is extremely bad; all that the surgeon can do is to remove, as completely as possible, the cause of the infection.

SEPTIC THROMBOSIS OF THE LATERAL SINUS.—*Anatomy.*—The lateral sinus turns downwards and forwards at a point about ten millimetres behind the suprameatal spine to form the sigmoid sinus which terminates in the bulb of the jugular vein in the jugular fossa (Fig. 7). Its course, however, varies very much. In children, owing to the shallowness of the sigmoid groove, it does not project so far forward. In adults, especially in brachycephalics, the sigmoid sinus often projects farther forwards on the right side than on the left.

In septic infection of the sigmoid and lateral sinuses, *the following are the chief paths along which infection can spread to other parts*:—

(1) The superior petrosal sinus, which receives the blood from the cavernous sinus, from the inferior cerebral and the superior cerebellar veins, and also from some small veins of the tympanic cavity. (2) The inferior petrosal sinus, which also drains the cavernous sinus and receives the inferior cerebellar and labyrinthine veins. (3) The occipital sinus, which forms a communication between the sigmoid sinus and the posterior spinal veins. (4) The mastoid vein, which passes through the skull at a point thirty millimetres behind the suprameatal spine and communicates with the deep veins of the neck; and (5) In addition some small veins which pass through the anterior and posterior condylar foramina and join the sigmoid sinus as it terminates in the jugular bulb.

Pathology.—Although clinically the onset of the symptoms of septic thrombosis of the lateral sinus is always sudden, yet involvement of the sinus itself is a gradual process. As the bone disease spreads to the wall of the sinus, its outer surface becomes covered with purulent lymph or pus. In consequence of this, acute inflammatory changes take place in the wall of the sinus from without inwards, so that it may become thickened from proliferation of new cells, and its outer surface may become covered with granulations. As its inner endothelial lining becomes involved in the inflammatory process thrombosis occurs at the site of infection. This is nature's attempt to limit the disease. If the thrombus is limited to part of the vessel wall and does not obstruct its lumen, it is termed *parietal*; when it completely blocks the vessel, it is known as an *obstructive* thrombus.

In the earlier stages the thrombus may not be infective; but later, as a result of bacterial infection, it becomes septic, and then it softens and disintegrates. Provided the septic thrombus is shut off from the general circulation by non-infective clot on each side of it, general infection will not take place, but eventually owing to the breaking down of this barrier, small particles may be swept into the general circulation, giving rise to pyaemia. Thrombosis of the lateral sinus most frequently occurs in its sigmoid portion, but occasionally the bulb of the jugular vein becomes infected through the floor of the tympanic cavity.

The pathological changes within the sinus vary very greatly; on the one hand there may only be a small septic focus surrounded on each side by normal clot;

on the other hand, the sinus may be converted into a tube filled with pus. In other cases the outer wall of the sinus may ulcerate through at the site of the infection, exposing the inner wall covered with granulations, whilst, above and below, the lumen of the sinus may have become completely obliterated from organization of the protective clot and from thickening of its walls. Thrombosis may extend in both directions. It may spread backwards to the torcular Herophili and even to the transverse sinus of the opposite side; or along the longitudinal sinus, or downwards along the jugular as far as the innominate vein; or along any of the venous channels communicating with the lateral sinus, more especially the petrosal, perhaps ultimately involving the cavernous sinus.

Symptoms.—The symptoms vary, being dependent on the extent of the local lesion and on the amount of septic absorption which has already taken place. In the earlier stages the local symptoms predominate; in the later stages, the constitutional. *If the infective thrombus is limited and surrounded on each side by healthy clot, there may be no constitutional symptoms* but merely the local symptoms of an abscess under tension, and the condition may only be discovered at the time of operation. The characteristic symptoms are due to infective particles of clot being carried into the circulation as a result of septic disintegration of the thrombus.

As a rule the onset is sudden and is ushered in with rigors, which are characteristic of septic thrombosis. The temperature is very irregular; it varies from 102 to 104, occasionally sinking to below normal; and again, after a rigor has taken place, suddenly rising even to 105. In the earlier stages there is loss of appetite, a general feeling of malaise, and constipation; and there may also be attacks of vomiting and giddiness. There is usually pain in the head on the affected side and there may be delirium at night, but the patient's mental condition as a rule remains quite clear and consciousness is retained until the end.

Objective signs.—The discharge from the ear may be profuse, or so slight as to have been ignored so that there may be a complete denial of middle ear suppuration. Usually, however, examination of the ear shows the presence of an old perforation or definite signs of bone disease. There may be no external signs of inflammation of the bone, but there is frequently tenderness on pressure *behind* the mastoid process, which is always a suggestive sign of an abscess round the sinus or of thrombosis. Optic neuritis is present in fifty per cent. of cases.

Depending on the extent of the thrombosis the following objective signs may be found:—(1) If the jugular vein becomes thrombosed a thickening may be felt along its course, but this, however, is usually due to enlargement of the cervical glands rather than to thrombosis of the jugular vein itself. As a result of periphlebitis and involvement of the surrounding soft tissues there may be oedema, brawny swellings, or abscesses of the neck. (2) Similarly, involvement of the deep cervical veins may give rise to deeply situated abscesses at the back of the neck. (3) Extension along the petrosal sinuses may lead to thrombosis of the cavernous sinus, and to subsequent exophthalmos, chemosis, oedema of the eyelids, periorbital abscess, or panophthalmitis.

In the later stages the symptoms are chiefly those of pyaemia, of which the pulmonary complications, such as broncho or pleuro-pneumonia, empyema or gangrene of the lungs are the most common. Before death occurs there may, in addition, be pericarditis, acute suppuration of the joints, splenic enlargement or offensive diarrhoea; and the general apathetic condition of the patient from toxic infection may closely simulate enteric fever. Occasionally meningitis masks all other symptoms.

Diagnosis.—The occurrence of rigors in a middle ear suppuration, unless there are other causes to account for them, is practically pathognomonic of lateral sinus thrombosis, especially if optic neuritis is present. If the head symptoms are prominent, the diagnosis has to be made from meningitis or an intracranial abscess (*see* p. 264).

In any case of illness in which head-symptoms are present and rigors occur, the ears should be carefully examined. If this precaution is neglected lateral sinus thrombosis may be mistaken for enteric fever, miliary tuberculosis, malignant endocarditis or malaria; or, if the pulmonary symptoms predominate, for pleuro-pneumonia.

Treatment.—The principles of treatment are to freely expose the sinus and completely remove the infected clot, without permitting any particles of it to be swept off into the general circulation. In some cases the operation is extremely easy; in others, if the disease is extensive, it may be practically impossible to completely remove the infected clot.

The first step is to perform the complete mastoid operation, except in cases of acute inflammation of the mastoid when Schwartze's operation may be sufficient. The bone is chiselled away in a backward direction along the line of diseased bone, so as to expose the outer wall of the sinus for at least half an inch above and below the infected area. The method of procedure now depends on the condition found. Normally the sinus pulsates and is of a bluish grey colour. If thrombosed, the wall of the sinus may be of a yellow or dark purplish colour and may not pulsate ; but neither the discoloration nor the absence of pulsation is an absolutely reliable sign of thrombosis. If the sinus is covered with granulations or purulent lymph it is sometimes impossible to say whether it is thrombosed or not, especially if the clot is limited and parietal.

Palpation of the sinus with the finger or *aspirating of the sinus* with a hollow needle are sometimes advised as aids to diagnosis. Both these procedures are dangerous, owing to the risk of dislodging a small fragment of the infected clot, which may easily occur if the clot does not completely obliterate the sinus. Also from a diagnostic point of view the withdrawal of blood by the aspirating needle does not negative the presence of a parietal thrombus.

The first question to decide is whether there is thrombosis, or whether the symptoms may not be due to septic absorption from an abscess round the lateral sinus.

1. If, from the clinical symptoms and the appearance

of the sinus wall, the diagnosis is doubtful, the sinus should not be opened, but the wound should be carefully cleansed, lightly packed with gauze, and left open. On no account should any granulations on the sinus wall be curetted away, and during the operation the sinus should be disturbed as little as possible.

In exposing the lateral sinus it is wiser to use the gouge or chisel rather than the bone forceps or burr, as by the former method there is less risk of the sinus wall being disturbed and of particles of septic clot being dislodged and carried into the circulation.

2. When it is certain that thrombosis exists, the first step is to isolate the infected area, before the sinus is in any way interfered with.

A plug of gauze is inserted between the sinus and its outer wall, so as to completely obliterate its lumen at least half an inch above and below the thrombus. The outer wall of the sinus is then freely slit up, the clot being removed by gentle curetting and the sinus swabbed out with a strong antiseptic solution and lightly plugged with a strip of gauze. After cleansing the operation wound cavity it is also lightly plugged with gauze and left open.

If the infected thrombus is limited and has apparently healthy clot on each side of it, some authorities advise that it is only necessary to curette away the septic portion. It is possible that such treatment may have a favourable result, but the procedure is somewhat dangerous. *It is only justifiable if there have been no constitutional symptoms of septic infection.* That is, if there have been no rigors, no pyrexia, and if the thrombosis has been merely accidentally discovered during the course of the mastoid operation. Even in these cases symptoms of pyaemia may occur later on, owing to the apparently normal clot having already become infected. *In any case the obstructing clot should never be curetted away until the lumen of the sinus has been carefully obliterated, as there is no doubt that the curetting away of a thrombus from the lower end of the sinus until bleeding occurs has in some cases been responsible for the occurrence of subsequent pyaemia.*

If the operation has been successful, the temperature becomes normal and the other symptoms rapidly disappear. The wound should be redressed within twenty-four to forty-eight hours, depending on the condition found on operation. The pluggings between the wall of the sinus and the bone should not be removed until the third day, and then carefully, in case of haemorrhage. If this takes place the sinus must be re-plugged. The after-treatment consists in re-dressing the wound daily or every second day, special care being taken to allow of free drainage.

Ligation of the Jugular Vein.—As has already been stated, it is necessary to completely remove all the infective clot. If this cannot be done by the operation already described, owing to the clot extending too low down, it becomes necessary to ligature the jugular vein.

The indications for this operation in connexion with lateral sinus thrombosis are still under discussion. Owing to the large proportion of cases which end fatally, it is wiser, in cases of doubt, to do a too extensive operation than to leave behind any of the infective clot, as it is well known that if the first operation is not successful further operations are usually of little value owing to the infection having already become general.

As an argument against ligation of the jugular vein it is asserted that it favours extension of the thrombus along the veins communicating with the jugular bulb, especially along the inferior petrosal and cavernous sinuses; and cases have been mentioned where, as the result of this back pressure, acute inflammation of the cerebellum has taken place.

It must be remembered that the *jugular vein should only be ligatured if it is impossible to obliterate the sinus below the thrombus in those cases in which the symptoms point to the onset of a general infection of the circulation.* As the jugular vein is the chief route by which this infection takes place, it seems a matter of common sense that it should be ligatured. Although extension of the infection along other veins may take place after ligation of the jugular vein, it is impossible to say whether the result is *post or propter hoc.*

Indications for ligation of the Jugular Vein may be summarized as follows :—

1. *After exposure of the Lateral Sinus.*—(*a*) When the occurrence of rigors show that the general circulation has become infected and it is impossible to obliterate the lateral sinus below the lower limit of the thrombus. (*b*) If there is thrombosis of the bulb of the jugular vein. The diagnosis of this condition has to be made from the occurrence of rigors in a middle ear suppuration in which there is no sign of disease of the lateral sinus.

The probability of the diagnosis being correct is strengthened by the presence of granulations or carious bone on the floor of the tympanic cavity.

2. *Before exposure of the Lateral Sinus.*—As the first step of the operation. (*a*) When it is certain there is thrombosis of the jugular vein itself. (*b*) When the general condition of the patient, from septic infection, is so serious that a prolonged operation seems impossible. In these cases, after tying the jugular, the lateral sinus is rapidly exposed, incised, its contents curetted out and lightly plugged. The operation, if necessary, is completed next day. (*c*) If, at a previous operation, the lateral sinus was merely exposed but not opened, and if afterwards symptoms point to involvement of the sinus.

The technique of ligaturing the Jugular Vein.—This is a simple procedure, and is described in the text books of general surgery.

The vein is exposed at the level where it is joined by the common facial vein. If the thrombus is above this point, the jugular vein should be tied between two ligatures above the entrance of the common facial vein. If the thrombus extends below this point then the common facial must also be ligatured. After cutting through the vein between the ligatures its upper portion is dissected upwards and brought into the upper margin of the neck wound, which is now closed. The surgeon then turns to the mastoid cavity and exposes the sinus as far down as it is possible towards the bulb of the jugular fossa. After obliterating the lumen of the sinus above the clot by inserting a piece of gauze between the bone and its outer wall, it is now freely opened, its outer wall cut away, and the contents gently curetted out. The lower portion of the sinus with the upper part of the jugular vein is now washed through with a weak solution of biniodide of mercury. The nozzle of the syringe is inserted into the lower opening of the sinus, and the fluid syringed through so that it flows out of the end of the vein which has been brought into the neck. The end of the jugular vein is kept in position in the upper margin of the wound in the neck by means of a suture, and the wound behind the ear is plugged with gauze. The ordinary dressings are now applied. Theoretically the correct treatment in thrombosis is to expose the sinus, bulb of the jugular and the jugular vein throughout their whole length. This has been done in several cases, but the anatomical position of the jugular fossa makes the procedure by no means an easy one.

Terminations.—1. *If no operation is done.*—The result is usually fatal from resulting meningitis, intracranial abscess (usually cerebellar) or extension of the thrombosis in other directions, resulting in pyaemia, which may last two or three months before death takes place. Recovery, however, is possible from the thrombus on each side of the septic clot becoming organized and the contents of the sinus draining into the mastoid cavity.

2. *If an operation is done.*—The prognosis of recovery is more favourable in proportion as the general symptoms are slight, the thrombus limited in extent, and the shortness of its duration before the operation.

In spite of the most extensive operative measures death may take place owing to the operation having been performed too late, so that the infected thrombus cannot be completely removed, or owing to general pyaemic infection having already occurred.

With regard to ligation of the jugular vein, there is no doubt that many cases recover as the result of this operation, which would otherwise have died.

INTRACRANIAL ABSCESS.—Intracranial abscess is almost invariably the result of chronic middle suppuration. It may, however, occur in the course of an acute suppuration, even without perforation of the tympanic membrane. *As a rule an intracranial abscess of otitic origin is situated close to the surface of the brain, in close relationship to the area of diseased bone through which the infection has spread.* Sometimes the bone disease can be traced as far as the dura; in other cases adhesions unite the surface of the bone, the dura mater, and the surface of the brain together, and occasionally a fistula will be found leading into the brain substance towards the abscess cavity. Occasionally the abscess is deeply situated, so that there is apparently no communication between the brain abscess and the diseased bone of the mastoid process. The infection in these cases has probably been carried to the brain by means of blood vessels or lymphatics.

Intracranial abscess is most common between the ages of ten and thirty. In 100 cases which I collected from the records of the London Hospital, I found that in children under ten years of age, temporo-sphenoidal abscess occurred in 87 per cent. and cerebellar only in 13 per cent., whereas in adults cerebral abscess occurred in 65 per cent. and cerebellar in 35 per cent. A cerebral and cerebellar abscess occurred together only in 5 per cent. of the cases. Occasionally there are multiple abscesses in the temporo-sphenoidal lobe or cerebellum; this however is very rare, and is usually the result of pyaemia. If of recent origin, the walls of the abscess cavity may be irregular and indefinite, but in the more chronic conditions it is surrounded by a capsule. The size of the abscess varies; a temporo-sphenoidal abscess may become very large.

Attic suppuration tends to lead to temporo-sphenoidal abscess; disease of the posterior group of mastoid cells to abscess of the lateral lobe of the cerebellum. In internal ear suppuration, if an intracranial abscess occurs, it is usually situated in the cerebellum opposite to the internal auditory meatus.

Symptoms.—The symptoms depend on the size of the abscess and at what period of the disease the patient first comes under observation. If the abscess is large and situated in the temporo-sphenoidal lobe, the symptoms of intracranial pressure will be well marked. On the other hand, a small abscess of the cerebellum may show no sign of its existence until death suddenly occurs from its rupture, or from pressure on the respiratory centre.

The course of an intracranial abscess may be divided into four stages; the initial stage, the latent stage, the stage of manifest symptoms, and the terminal stage.

In the *initial stage* there may be headache, slight pyrexia or even a rigor, and occasional attacks of vomiting. These symptoms may rapidly subside and the condition becomes latent.

The *latent stage* may exist for a considerable time, perhaps a year or two, it is difficult to say how long, until suddenly the marked symptoms of an intracranial lesion make their appearance.

During the period of latency the patient, however, is not in a good state of health. There may be attacks of headache, a disinclination to work, or some change may be noticed in the temper or habits of the patient, who may from time to time do some eccentric action.

The *manifest symptoms* of intracranial suppuration are for convenience divided into three groups, namely, general symptoms, symptoms due to intracranial pressure and localizing symptoms.

1. **The general symptoms** are due to septic absorption, and consist chiefly in lassitude, a general feeling of malaise, constipation and loss of appetite. With this there is often much wasting, and the patient may have a peculiar yellowish or muddy looking complexion.

2. **Symptoms of intracranial pressure.**—The most prominent symptoms are: (*a*) *headache*, which may be general, but in temporo-sphenoidal abscess may be referred to that side, or in cerebellar abscess to the occiput; (*b*) *vomiting* of an irresponsible, gushing character, having no relation to the taking of food; this is more marked in cerebellar than in cerebral abscess; (*c*) *optic neuritis*, which is an important sign when present: it is usually double-sided, although frequently more marked on the affected side; (*d*) *a subnormal temperature*; in the initial stage it may have been slightly above normal; (*e*) *a slow bounding pulse*, frequently not amounting to more than fifty beats per minute.

As the intracranial pressure increases, a marked change in the mental condition of the patient becomes apparent.

There may be apathy, slowness of comprehension of speech, and slowness in answering questions (the so-called slow cerebration); or there may be attacks of complete forgetfulness or mental aberration; or at one time the patient may sit for hours in a semi-somnolent state, and at another time may be in a condition of mental excitement almost bordering on delirium. In the later stages there is an increasing drowsiness, and a tendency to lie curled up in bed with flexed extremities.

3. **Localizing symptoms.**—Although theoretically it may appear easy to distinguish between a cerebral and cerebellar abscess, from a practical point of view it is often extremely difficult. (*a*) In favour of *temporo-sphenoidal abscess* are symptoms of cerebral compression, such as paralysis of the opposite side, a slow bounding pulse, a subnormal temperature, and drowsiness eventually ending in coma. If situated on the left side, there may be aphasia, and if the abscess is very large there may be optic amnesia. An additional important symptom is deafness of the opposite side, due to pressure on the auditory centre. (*b*) In favour of *cerebellar abscess* are attacks of vertigo, a staggering gait, nystagmus, facial paralysis of the same side, rigidity of the neck muscles, absence of the patellar reflex, and paresis or paralysis of the extremities. In cerebellar abscesses the attacks of vomiting and the optic neuritis are said to be more marked than in temporo-sphenoidal abscess.

Terminal stage.—If the abscess is not opened by operation, death sooner or later occurs. It is possible, however (although it must be an exceedingly rare occurrence), for spontaneous cure to take place from the abscess draining into the middle ear. In temporo-sphenoidal abscess death takes place from the increased intracranial pressure causing gradual paralysis of its functions. In cerebellar abscess, owing to pressure on the respiratory centres, the breathing may become very irregular, and sometimes Cheyne-Stokes in character; death may occur unexpectedly from sudden cessation of the respiration. As a rule, the terminal stage is hastened by the abscess rupturing into the ventricles, or giving rise to acute lepto-meningitis or general septicaemia.

Diagnosis.—It must be borne in mind that occasionally the symptoms of an intracranial lesion may at once disappear by the simple opening of the antrum, or the performance of the complete mastoid operation. This is especially so in children, in whom all the cardinal symptoms of meningitis may occur as the result of retention of pus within the tympanic or mastoid cavity. In adults, however, it is extremely unusual for disease of the bone, limited to the mastoid process or middle ear, to give rise to any such symptoms. *Whenever an intracranial lesion is suspected, the ears should be examined. If they are normal, an intracranial lesion of otitic origin may be excluded.* If a middle ear suppuration exists, the question arises whether the intracranial condition is due to the aural affection, or whether it is merely coincidental. Examination of the ear and mastoid region is of the greatest importance. If there is evidence of a chronic middle ear suppuration, accompanied by headache on the affected side and pain on pressure over the mastoid, or some external sign pointing to an inflammatory affection of this region, it may be presumed that the primary cause of the intracranial lesion lies within the ear. Diagnostic mistakes have been made in the case of an otorrhoea occurring in the course of intracranial tumour, enteric fever, malignant endocarditis or uraemia. It is wiser to assume that the intracranial trouble is secondary to the aural affection, unless this can be excluded. After an intracranial lesion has been diagnosed, it is necessary to decide its character and situation. For the sake of clearness the chief points in the differential diagnosis of intracranial suppurative lesions may again be given.

1. *In meningitis.*—The onset is sudden. There is an irregular pyrexia accompanied by mental irritability, rapid pulse, retraction of the neck, squint, and twitchings, spasms or irregular paralyses of the face or extremities.

2. *In lateral sinus thrombosis* the onset is usually sudden, being ushered in by recurrent rigors. In spite of head symptoms the mental condition remains clear.

3. *In intracranial abcess* the onset is more gradual, and is accompanied by attacks of vomiting, increasing headache, optic neuritis, slow pulse, and a subnormal temperature.

It must not be forgotten that one or more of these complications may co-exist, so that it may be almost impossible to exactly determine the existing condition. The character of the temperature is a very important symptom. If repeated rigors occur, whatever other complications may exist, thrombosis may be diagnosed. Similarly, a high irregular temperature is not compatible with a simple intracranial abscess;

it means the onset of meningitis or some other complication.

Treatment.—The abscess must be opened and drained The radical mastoid operation is performed in the ordinary way.

The condition found will assist the surgeon in determining what part of the brain he should first explore. When the bone disease spreads upwards, involving the attic region or the tegmen tympani, the abscess should be sought for in the temporo-sphenoidal lobe. If, however, the disease spreads backwards, especially if there be an abscess round the sinus, or inwards along the petrous bone, the cerebellum should be first examined.

Technique of exploring for a temporo-sphenoidal abscess.—The wound cavity is first cleansed with biniodide of mercury solution, and its deeper parts lightly plugged with sterilized gauze. The bone is now chiselled away in an upward direction, so as to expose the dura mater at the base of the middle fossa. The opening should not be larger than a shilling in size. In favour of the presence of a temporo-sphenoidal abscess is congestion or discoloration of the dura mater and increasing tension of intracranial pressure, causing the dura mater to slightly bulge into the wound cavity: another suggestive symptom is the absence of pulsation. With a tenotomy knife the dura mater is now cut through by a cross-incision, the small flaps being then reflected. The brain is explored by means of a pair of fine-pointed Liston's forceps, which are inserted, with a decided thrust, in an upward and inward direction for a distance of not more than 1½ inches. The abscess is usually situated near the surface, and as a result of this puncture pus pours out. If the abscess is not struck at the first attempt, the forceps should be withdrawn and the brain again explored in a forward, backward, or more inward direction. After the abscess has been found, the points of the forceps may be slightly opened to allow of free drainage of the pus. After most of the pus has drained away, an india-rubber tube is inserted into the abscess cavity *before the forceps are removed.* If pus continues to exude from the outer extremity of the tube, showing it is in position, the forceps may now be removed. A single drainage tube is sufficient, but it should be of large size. The tube is kept in position by a suture uniting it to the edge of the skin incision. The surrounding parts are now cleansed with a mild antiseptic solution and gently packed. Those cases appear to do best in which the abscess cavity is not irrigated, and in which the surgical manipulations have been carried out as rapidly and gently as possible. After the operation, the pulse and respiration improve, and all the symptoms of cerebral pressure rapidly subside, so that even within twenty-four hours the patient may have almost recovered his normal mental condition with complete abatement of his previous severe headache. The outer dressings of the wound should be removed daily, exposing the tube so as to make certain that the abscess is draining freely. As the discharge ceases and the abscess cavity diminishes in size, the intracranial pressure will tend to push out the tube; it should be gradually shortened and eventually removed after the discharge has completely ceased.

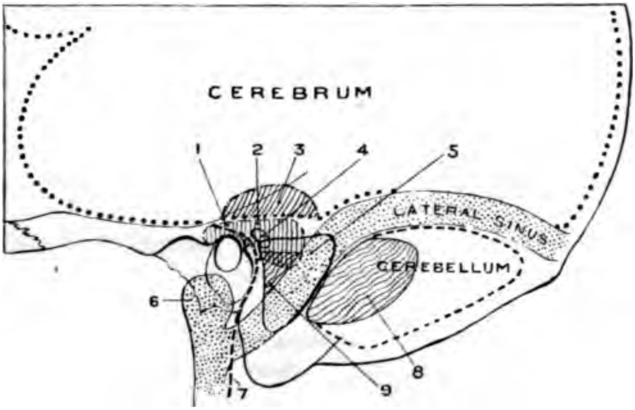


FIG. 15.—Diagram to show surgical anatomy for operations for Otitic Intracranial Lesions.

1. Attic.
2. Antrum.
3. Point for opening temporo-sphenoidal abscess (just above and along the tegmen tympani).
4. External semicircular canal.
5. Lateral sinus; also shows area of bone removed in mastoid operation.
6. Bulb of jugular vein.
7. Facial nerve.
8. Point for opening cerebellum behind lateral sinus.
9. Point for opening cerebellum in front of lateral sinus (between sinus behind and external semicircular canal in front).

Technique of exploring for a cerebellar abscess.—A cerebellar abscess may either be *superficial* or *deep*. The superficial abscess is usually associated with disease of the posterior mastoid cells, or as a result of an abscess round the sinus, and is situated close to the outer surface of the lateral lobe just beneath the tentorium. The deeply placed abscess is either the result of disease of the petrous bone anteriorly, or a complication of internal ear suppuration : it is situated in the anterior inferior portion of the lateral lobe, close to the internal auditory meatus. In the case of the superficial abscess the cerebellum must be explored behind the lateral sinus, but in front of it for the deeply placed abscess.

1. *In exploring the cerebellum behind the lateral sinus*, the bone is removed by the chisel or bone forceps for an area of one square inch, having the posterior margin of the lateral sinus for its anterior upper boundary.

After incising the dura mater behind the lateral sinus, the cerebellum is explored in a forward and inward direction. If, however, the abscess is not discovered at the first attempt, the cerebellum should be explored in other directions.

2. *To explore the cerebellum in front of the lateral sinus*, the bone should be removed between the sinus behind and semicircular canals in front, thus exposing the triangular area of dura mater which corresponds to the surface of the cerebellum lying behind and below the internal auditory meatus. In exploring the cerebellum in this situation, care must be taken not to go too far inwards and forwards.

The insertion of a drainage tube and the after-treatment is similar to that for temporo-sphenoidal abscess.

During the course of exploration of the cerebellum, it sometimes happens that respiration suddenly ceases owing to pressure on the respiratory centre. If this occurs, artificial respiration should be carried out whilst the surgeon continues the operation. As soon as the abscess has been evacuated, natural respiration will be quickly resumed.

Prognosis.—As has already been stated, an intracranial abscess almost invariably results in death, unless evacuated by means of operation. According to the records of the London Hospital, recovery took place in 20 per cent. of the cases operated on for cerebral abscess and 10 per cent. of the cerebellar. Other statistics give much higher percentages of recovery, but it must be remembered that in hospital patients a great many cases are only first seen by the surgeon when almost in a moribund condition, so that the operation is perhaps only performed as a forlorn hope. Sometimes the symptoms continue owing to the presence of another abscess; at other times the symptoms of intracranial pressure occur later on from the formation of a cyst at the site of the abscess; in other cases, in spite of recovery from the abscess, there may be attacks of severe headache, or cerebral irritation, or epileptiform seizures as the result of post-operative adhesions.

CHAPTER XII

DISEASES OF THE INTERNAL EAR

THE *Internal Ear* consists of the labyrinth, auditory nerve, and its central origin within the brain, but in considering the diseases of the internal ear we are practically limited to those occurring within the labyrinth.

As a rare condition the internal ear may be primarily affected by inflammations or haemorrhages, but as a rule it is secondarily involved, and most frequently as a result of middle ear disease.

Although from the subjective and clinical symptoms it may not be difficult to diagnose a lesion of the internal ear, yet it is sometimes impossible to definitely decide whether the lesion is situated in the labyrinth, in the auditory nerve, or in its central origin in the brain.

1. The auditory centre in the brain may be temporarily or permanently destroyed by shock, concussion, traumatism, or pressure from an intracranial tumour, abscess, or haemorrhage.

2. The auditory nerve may be injured in any part of its course from the brain to the labyrinth by a fracture of the base of the skull or from pressure of a gumma or other tumour. It may also be affected by certain drugs such as lead, arsenic and mercury.

3. Within the labyrinth, temporary or permanent injury may be caused by concussion from loud sounds, by traumatism, haemorrhages, or sudden changes of air-pressure as in divers and aeronauts. Working continually in a loud noise in some way affects the nerve terminals, a fact which is clearly shown by the high proportion of cases of nerve deafness occurring in boilermakers and riveters.

4. Many other conditions, such as vasomotor changes, poorness of nutrition, or the toxic action of certain drugs such as quinine, salicylic acid, or tobacco, probably affect both the auditory nerve itself and its terminals within the labyrinth.

5. Middle ear disease is by far the commonest secondary cause. In otosclerosis the symptoms of internal ear disease may occur before those of the middle ear, but more frequently it follows the middle ear affection. In chronic catarrh with adhesions, involvement of the internal ear is a late and gradual process. In acute inflammation or suppuration of the middle ear, owing to increased vascular congestion or transient inflammation of the labyrinth, symptoms of internal ear disease may occur, but usually soon subside. Absolute destruction of the internal ear, however, may occur as the result of an acute inflammatory or suppurative process which has extended to it from the middle ear, usually in the course of a chronic middle ear suppuration.

6. Internal ear disease may also result from acute specific fevers (especially scarlet fever, mumps and enteric fever), syphilis or tuberculosis. The latter, however, is almost invariably due to direct extension of the tuberculous process from the middle ear.

7. As the result of meningitis or cerebro-spinal meningitis the labyrinth may become involved in the inflammatory process which has extended along the internal auditory meatus.

Symptoms of Internal Ear Disease.—The chief symptoms of internal ear disease are tinnitus, vertigo, hyperaesthesia acustica and deafness. These symptoms may occur singly or together, and in varying proportion to one another. Their onset may be sudden or insidious, their course slow or rapid, temporary or permanent.

Deafness.—Mention has already been made of the various tests which are used to distinguish between a lesion of the conductive and perceptive portion of the auditory apparatus (p. 72). Characteristic of internal ear deafness is marked loss of the hearing power for high notes by air conduction, together with marked diminution or absence of bone conduction. In addition Weber's test is referred to the sound side, "Rinne" is positive and shortened, and Gelle's test is positive. As a rule when the deafness is slight, although the watch may not be heard, speech is still heard a considerable distance off. The onset of deafness may be sudden as in the case of acute inflammatory conditions of the internal ear, or insidious, when it is a sequela of otosclerosis or chronic middle ear catarrh. It is usually progressive and does not vary with regard to the weather or time of year, although frequently there may be temporary increase of the deafness as the result of mental or physical tiredness.

Tinnitus.—Although tinnitus is a symptom of increased irritability of the auditory nerve, yet in many cases it may occur from some external cause, or as the result of some central or peripheral reflex irritation without there being any disease of the labyrinth.

The subjective noises vary very greatly; they may be of high or low pitch, or they may be simple or complex in character, and may be compared by the patient to all kinds of external noises. When occurring secondary to middle ear disease they are usually at first intermittent, and it is only in the later stages that they become constant and unbearable. On the other hand, if due to some labyrinthine disturbance or to some reflex irritation, they may start with extreme suddenness and intensity. Subjective noises are more worrying to individuals of a neurotic temperament, and become more noticeable in proportion to the quietness of the patient's surroundings. For the sake of clearness the *most important causes of tinnitus* may be again mentioned: they are (1) Irritation or pressure within the external ear, such as may occur from impacted cerumen. (2) Acute middle ear catarrh or suppuration, probably by causing hyperaemia within the labyrinth. (3) Chronic middle ear catarrh or otosclerosis from extension of the pathological changes to the labyrinth from the middle ear. (4) Vasomotor changes as seen in arteriosclerosis, anaemia or plethora. (5) Nervous tinnitus, that is, subjective noises occurring without any obvious cause, is usually found in the neurotic or neurasthenic. It is, however, sometimes met with in patients who in other respects are apparently healthy. (6) Tinnitus may also be an early symptom of an intracranial tumour or aneurism.

Hallucinations of sound, rather than simple noises, usually only occur in those mentally affected.

Vertigo.—There are many causes giving rise to vertigo, but only those which are of aural origin will now be considered. Vertigo may be produced reflexly from syringing the ear (especially with cold water), from the presence of foreign bodies within the auditory canal, or from sudden explosive noises. It may occur as a result of marked retraction of the tympanic membrane, or of forcible inflation of the middle ear, or in the course of chronic middle ear catarrh or otosclerosis. Like tinnitus, it may also be due to hyperaemia, inflammation, or some circulatory disturbance within the labyrinth, or be a symptom of a cerebellar abscess or intracranial tumour.

Although the clinical symptoms may point to the vertigo being caused by a lesion of the semicircular canals, yet in most cases it is associated with the other symptoms of internal ear disease dependent upon some general disturbance of the labyrinth. The onset is usually sudden, but may vary greatly in its intensity. There may be merely a slight swimming in the head or a swaying in the gait when walking, or on the other hand, the seizure may be so severe as to simulate an attack of epilepsy. The attacks also vary greatly in their frequency.

Vertigo due to a lesion of the semicircular canals.—In these cases the vertigo is definite and peculiar in character. If there is irritation of the nerve terminals within the external semicircular canal the patient tends to fall towards the affected side, whilst the objects in front of him rotate in a horizontal plane. If, however, the superior semicircular canal be involved, the patient tends to fall forward and the objects appear to him to fly upwards.

Caries of the external semicircular canal is not an unfrequent sequela of chronic middle ear suppuration, and is often accompanied by lateral nystagmus.

Diagnosis of Internal Ear Disease.—In the diagnosis of internal ear disease, the greatest importance must be attached to the result of the tests of hearing, to which reference has already been made. The diagnosis is further confirmed if the tympanic membrane is normal, the Eustachian tube patent, and if on inflation there is no improvement in hearing. In otosclerosis the middle ear may appear normal, but the tuning-fork tests will show signs of middle ear disease. Occasionally in otosclerosis the internal ear becomes involved at the same time as the middle ear, and then the tuning-fork tests may be somewhat indefinite. The diagnosis of a labyrinthine affection secondary to a middle ear inflammation or suppuration, or to some other external cause, is based on the occurrence of internal ear deafness accompanied by one or more of its characteristic symptoms. If the symptoms of internal ear disease occur without the middle ear being affected, a careful examination of the central nervous system should be made to localize, if possible, the origin of the disease.

Treatment of Internal Ear Disease.—If secondary to middle ear disease it is necessary to treat the primary cause. If there are no objective signs of middle ear disease, local treatment is useless; in fact, inflation of the ear or massage may temporarily increase the deafness or give rise to tinnitus or vertigo. Similarly in otosclerosis, local treatment is contraindicated. In a simple progressive nerve deafness, nothing very much can be done. If the patient is anaemic or is convalescing from some serious illness such as enteric fever, the chief indications of treatment are to restore the general health. Of internal remedies the best is strychnine, which should be begun in small doses and increased rapidly as far as can be done without any harmful effect. (For the treatment of the acute varieties, *see* Syphilis and Menière's Disease.)

The two most distressing symptoms for which the patient seeks treatment are tinnitus and vertigo.

Treatment of Tinnitus.—The treatment of tinnitus in middle ear disease has already been mentioned (*see* p. 116). Any obvious condition such as anaemia, plethora, or circulatory disturbances must be treated. If occurring in the course of internal ear disease, in addition to sedatives, a rest cure may be tried. Occasionally counter-irritants over the mastoid process, or galvanism are of service.

Recently, "Valyl," a preparation of valerian, has been strongly recommended as a remedy for tinnitus occurring in patients of a nervous or neurotic temperament. Sometimes change of climate, especially to a high and dry altitude, or a sea voyage is of great benefit.

Operative treatment has been suggested when the tinnitus is so distressing as to be no longer endurable. Attempts have been made to give relief by ligaturing the common carotid or dividing the auditory nerve at the internal auditory meatus; these procedures have not been successful, but as a result of the operation hemiplegia or facial paralysis have occurred.

Treatment of Vertigo.—It is first necessary to discover its cause, which must be treated. If the onset is sudden as in Menière's Disease (*see* p. 279), rest in bed is essential. To relieve congestion of the vessels, free purging is indicated, especially if the patient is plethoric. In addition a blister or leeches may be applied to the mastoid process ; the diet must be light, and if necessary limited to fluids, until the acute attack has passed off. Considerable relief is often obtained by the application of cold compresses to the head and the giving of a mustard bath to the feet. Of the internal medicines the most beneficial are bromides. If syphilis is suspected, or if there are any signs of arteriosclerosis, potassium iodide should be given in combination with the bromides. If the character of the vertigo suggests irritation of the semicircular canals, especially if associated with tinnitus, quinine is often of great benefit. It should be given in large doses (from 3 to 5 grs. three times a day in combination with a drachm of dilute hydrobromic acid), and continued for three or four weeks, and then gradually diminished. It must be remembered, however, that quinine occasionally increases the deafness and the subjective symptoms, in which case its administration must be at once stopped.

After the acute attack has passed off, a feeling of giddiness may still remain. The treatment should be continued, though in a modified form, for a considerable period, and the greatest care taken with regard to diet and the avoidance of excitement. Anything which causes congestion of the head, such as over-smoking, over-indulgence in alcohol, mental strain, or over-exertion, will tend to cause a renewal of the attack.

Operative Treatment.—(1) *Ossiculectomy.*—This operation is only justifiable if all other means of local and internal treatment have failed, and the attacks of vertigo are apparently due to increased pressure within the labyrinth as a result of retraction inwards of the membrane and ossicles.

The conditions justifying this operation, however, are extremely rare.

(2) *Removal of the semicircular canals.*—If from the symptoms a lesion of the semicircular canals can be diagnosed (usually the external), and if all local and internal treatment has been unsuccessful, this operation may be considered. If the patient is not very deaf he must be warned of the probability of the operation making him so, for although theoretically it should be possible to operate on the semicircular canals without in any way injuring the cochlea, this is very liable to occur.

The technique of the operation is the same as that described for internal ear suppuration (p. 283). The chief dangers are facial paralysis and meningitis.

Up to the present the records of the results of this operation are too few to determine its value, but it has already been successful in one or two cases.

MENIÈRE'S DISEASE.—The term Menière's Disease is applied to the sudden onset of nerve deafness accompanied by signs of acute irritation of the nerve terminals within the labyrinth. The first case was described by Menière, who found the semicircular canals filled with haemorrhagic exudation, whilst the cochlea was apparently normal. From this it was assumed that the condition was due to acute haemorrhagic effusion within the semicircular canals. Although the clinical symptoms of the condition described by Menière are now well recognized, it is uncertain whether they are really due to the pathological condition first described.

Causes.—The cause is usually obscure, but is attributed to over-exertion; it usually occurs in a previously healthy adult.

Symptoms.—The onset is markedly sudden. There may be a premonitory buzzing noise in the ears, and a feeling of giddiness ; as a rule the patient falls suddenly to the ground without even having time to break his fall. There is rarely complete loss of consciousness, but if so it is momentary. The patient lies on the ground in a state of collapse ; there is usually extreme pallor and sweating of the face, and there is a feeling of nausea or actual vomiting. The vertigo may be so severe that if the attack occurs when the patient is alone, he may be unable to move for some considerable time. There is usually marked tinnitus, and nystagmus may also be present. One or both ears may be affected. The deafness is marked or complete, and tuning-fork tests show that it is due to involvement of the internal ear. Examination of the middle ear and tympanic membrane show them to be normal.

Course of the Disease.—Consciousness rapidly returns ; the vomiting may last only a short time, but the giddiness and vertigo remain for a considerable period, and after these symptoms have passed off a staggering gait may be observed for a long time. The tinnitus may disappear shortly after the attack, but sometimes continues even after total deafness has occurred. The attack varies very greatly in its intensity, and may last only for a few minutes or continue for two or three days. No recurrence may ever take place, or, on the other hand, they may be frequent, occurring at varying intervals and of varying severity.

Diagnosis.—The two chief conditions from which Menière's Disease has to be diagnosed are

(1) *Menière's Symptom-Complex* and (2) *Epileptiform Seizure.*—In the course of chronic middle ear catarrh, in arteriosclerosis, or as a result of increased pressure within the labyrinth from retraction of the tympanic membrane, symptoms very similar and almost as acute in onset as those of Menière's Disease may possibly occur. This condition, however, is distinguished from true Menière's Disease by the tuning-fork giving the tests for middle ear disease.

In an epileptiform seizure there is always loss of consciousness, and although the aura preceding the attack may be referred to the ear and may be marked by a feeling of giddiness or the presence of tinnitus, yet after the attack has passed away these symptoms are found to have disappeared and the patient's hearing to be normal.

Treatment.—Rest in bed is essential, preferably in a quiet and darkened room. The treatment is the same as that already described for vertigo. Bromide of potassium, in at least 20 grain doses three times a day, is probably more serviceable than any other drug. In order to favour the absorption of the exudation within the labyrinth, hypodermic injections of pilocarpine may be given every alternate day beginning with one-twelfth grain and increasing the dose gradually to one-sixth grain. Potassium iodide is indicated if there is a syphilitic history, and quinine may be tried up to the point of cinchonism if there is marked tinnitus.

Prognosis.—Although partial recovery may be possible, as a rule the deafness remains complete, or only slight improvement takes place.

INFLAMMATION OF THE LABYRINTH (*Otitis Interna*).—Labyrinthine inflammation may either be non-suppurative or suppurative :—

(1) **Non-suppurative Inflammation.**—Its chief causes are acute specific fevers, syphilis, and more rarely acute middle ear suppuration, and purulent or cerebro-spinal meningitis.

The chief *symptoms* are a markedly increasing nerve deafness accompanied by tinnitus, vomiting and vertigo. Nystagmus may also be present, especially if the semicircular canals are involved.

The **treatment** consists in keeping the patient in bed, fever diet, free purging and the application of blisters or leeches to the mastoid process. In addition the primary condition must be treated.

The **prognosis** is uncertain. If occurring as a sequela of acute middle ear suppuration the condition is usually transient; if the result of specific fevers it may be permanent; if syphilitic in origin, the course of the disease is usually so rapid as to produce complete deafness unless the patient comes under observation within two or three days of its onset.

As a sequela of meningitis or cerebro-spinal meningitis, the deafness is usually complete and permanent, and in addition there may for some time be a peculiar, waddling or staggering gait.

2. **Labyrinthine Suppuration.**—Its chief causes are suppuration of the middle ear, tuberculous disease, meningitis, pyaemia and injuries.

The most frequent route of infection is through a fistulous track in the horizontal semicircular canal, which is not uncommonly found as a result of cholesteatomatous formation. The labyrinth may be partially or completely involved. The disease may run an acute or chronic course. If *acute* there is pyrexia, marked vertigo, nausea or vomiting, deep-seated earache and nystagmus, and with this a rapidly increasing nerve deafness. In the more *chronic* form, which is frequently due to tuberculous disease, the symptoms are not so well marked; pain may be absent and the vertigo is not so characteristic, being more of the nature of a swimming sensation in the head, and there may be no vomiting. A rapid onset of nerve deafness accompanied by nystagmus, together with one or more of the foregoing symptoms, is always suspicious of involvement of the internal ear. Facial paralysis occurring in the course of chronic suppuration of the middle ear is also an important symptom.

If the labyrinth is completely destroyed there may be no symptoms except complete deafness.

Diagnosis.—The chief difficulty in diagnosis is that of cerebellar abscess. In *cerebellar abscess* there is a tendency for the patient to fall towards the opposite side of the lesion; there may be optic neuritis, and the tuning-fork tests show the presence of middle ear disease. *In internal ear suppuration* the gait is of a swaying or staggering character, there is no optic neuritis, and tuning-fork tests are those of internal ear deafness.

Treatment.—The complete mastoid operation should be performed and the posterior wall of the meatus removed as freely as possible. The wound cavity is then inspected. The most usual site of a fistula is n the external semicircular canal. This may appear as a black spot, or through it pus may exude or granulations may protrude. Frequently granulations also cover the promontory, and on their removal a fistula may be seen involving the internal ear. If the only apparent lesion is a fistula in the external semicircular canal, the opening should be enlarged by means of a tiny gouge or chisel to see how far the disease extends. If there are no signs of suppuration within the canal it is not advisable to proceed any further, but the case should now be watched for two or three days to see if the symptoms subside. If the symptoms continue, it may be necessary to completely open up the labyrinth. If, after performing the complete mastoid operation, pus is seen to exude from the semicircular canal at the region of the promontory or one of the fenestrae, the internal ear should be thoroughly explored.

The opening is made through the promontory by means of a small gouge, and any granulations are carefully curetted out. Similarly if there is a fistula of the external semicircular canal a fine probe should be passed into it, and its outer wall removed until the vestibule is reached. A probe can now be passed beneath the facial nerve from one opening to the other. In cases of suspected cerebellar abscess occurring in internal ear suppuration, the cerebellum should be reached through the median wall of the mastoid antrum at the posterior part of the labyrinth, or through the labyrinth itself, so as to expose any existing extradural abscess which, as the result of internal ear suppuration, may possibly be found on the posterior surface of the petrous bone.

Prognosis is always grave owing to the frequency with which meningitis occurs. Operation gives a better chance of recovery. If recovery does take place, owing to the destruction of the labyrinth, complete deafness remains except in those rare instances where the disease has been limited to the semicircular canals.

CHAPTER XIII

DISEASES OF THE EAR IN ACUTE INFECTIOUS AND OTHER DISEASES

In acute infectious diseases all the varying conditions of catarrh or inflammation of the middle and internal ear may be met with, but in addition they have certain clinical features which are worthy of mention.

1. **Measles.**—Two varieties of otitis media occur in measles.

(1) *A middle ear catarrh* which usually occurs soon after the appearance of the rash, and which may perhaps be considered as representing a true measles eruption of the mucous membrane, and in which the only noticeable symptom may be deafness. Occasionally the otitis media is more acute, but as a rule the inflammation subsides without perforation.

(2) *Acute middle ear suppuration* usually occurs later, about the third week. It is probably due to secondary infection of the ear. Its course is the same as that of a simple middle ear suppuration.

Measles is said to be a special cause of internal ear deafness and of acquired deafmutism, but it is doubtful if this is the case.

The catarrhal condition tends to run a very chronic course, and for this reason if the treatment is neglected in the earlier stages it may lead to chronic middle ear catarrh.

2. **Scarlet Fever.**—Scarlet fever is not only one of the most common causes of aural disease, but one of the most serious factors in the production of deafness, owing to the destructive changes it frequently gives rise to within the tympanic cavity.

According to statistics, about 4 per cent. of all aural affections and 12 per cent. of all cases of middle ear suppuration are directly due to scarlet fever.

(1) It may occur in the early days of the fever as a *very acute destructive form of middle ear suppuration*, which may rapidly extend to and involve the mastoid process. This virulent form is especially prone to occur if, in addition to the scarlet fever, diphtheritic infection is also present. So long as the true origin of scarlatina is unknown it is impossible to say whether the disease is simply an extension of the inflammation along the Eustachian tubes, the result of acute tonsillitis and pharyngitis occurring in the early stage of the disease, or whether it is the result of a true scarlatinal infection.

(2) *Acute middle ear suppuration* may not occur until the period of desquamation, that is about the third or fourth week. Although there may be rapid congestion of the tympanic membrane and spontaneous perforation with marked destruction of the drum, yet, in spite of this, there is often a remarkable absence of pain.

(3) *Acute Inflammation of the Internal Ear* may also occur, usually as the result of extension of the middle ear disease.

Treatment.—In the earlier stages of the disease owing to the rapidity with which middle ear suppuration may occur, the ears should be examined at least once daily. As soon as the membrane becomes congested and bulges it should be incised. This timely measure frequently prevents extensive destruction of the membrane which otherwise may take place. There is a special tendency for the disease to resist treatment. In a large proportion of cases the ossicles, the bony walls of the tympanic cavity, and the mastoid cells become involved. Owing to this fact, it has recently been advised that the mastoid operation should be performed at an earlier period than is usually done in the ordinary suppurative lesions of the middle ear.

Prognosis.—When the involvement of the middle ear is due to an extension of the inflammatory process along the Eustachian tubes, the usual result is complete recovery. When, however, there are extensive destructive changes within the tympanic cavity, or formation of post-suppurative adhesions, deafness of a greater or lesser degree remains. If the internal ear has become involved in the inflammatory process, deafness may be complete. Scarlet fever, as is well known, is one of the chief causes of acquired deafmutism.

3. **Enteric Fever.**—A middle ear inflammation or suppuration is not uncommon in the course of enteric fever, and generally occurs in the fourth or fifth week of the disease. It may occur as a simple middle ear catarrh which subsides, or as an acute suppuration which may possibly end in involvement of the mastoid. Owing to the severity of the constitutional disease

the ear trouble usually escapes notice until the occurrence of otorrhoea. For this reason routine examination of the ears is advocated. During convalescence it may be noticed that the patient is extremely deaf, and on examination the deafness may be found to be of the internal ear type. Frequently complete recovery takes place as the patient gets stronger, so that in some of the cases the deafness is probably due to some pathological change in the auditory nerve centre as a result of toxic poisoning.

In all the infectious diseases any inflammatory affection of the throat should be treated as thoroughly as the general condition of the patient will allow.

Inflation of the ears should not be done until the acute throat and ear affection has subsided. As a rule adenoids and tonsils should not be removed, except in the quiescent stage. Dr. Knyvett Gordon, Medical Superintendent of the City of Manchester Fever Hospital, however, states that he never hesitates to remove adenoids and tonsils in such cases, even in the acutest stage of the throat affection, if they cause marked obstruction to breathing.

4. **Mumps.**—The chief aural complication is involvment of the labyrinth during the first few days of the disease. As a rule nothing pathological is found in the ear, and the patient remains absolutely deaf unless only one ear has been affected.

5. **Influenza.**—As the result of an influenzal cold it is not uncommon to get a simple middle ear catarrh. A typical influenzal otitis has special clinical

features. The onset and course are rapid, and the pain is very severe. Blebs and haemorrhages may be found on the tympanic membrane and external meatus. After perforation of the drum the course may be that of an ordinary middle ear suppuration, but there is a special tendency for acute mastoid inflammation to occur and to have, as a complication, an extradural abscess. In some cases the infection is so virulent as to cause death within a few days as the result of meningitis. Inflammation of the internal ear may also occur, from which recovery may take place with or without permanent nerve deafness, or death may occur later as the result of acute internal ear suppuration. Characteristic of influenzal aural complications is the persistence of otalgia or neuralgia of varying intensity for a considerable period after the acute symptoms have subsided.

Treatment.—As in the case of infectious fevers, as soon as indications arise for the performance of paracentesis or the mastoid operation, these operative measures should be carried out *promptly*.

6. **Tuberculosis.**—The usual site of the disease is the tympanic cavity, but the tuberculous process not uncommonly spreads to the internal ear. The external ear is rarely affected.

The disease may be primary, and if so, generally begins within the mastoid process. As a rule it is secondary to tuberculous disease elsewhere in the body.

The infection may reach the middle ear through the Eustachian tube either from infected sputum in cases of pulmonary phthisis, or from tuberculous disease of adenoid vegetations. In other cases the infection seems to take place through the blood stream.

It occurs far more frequently in children than in adults.

The course of the disease may be either acute or chronic, and one or both ears may be affected.

In the **acute form** there may be slight pyrexia, accompanied by earache and otorrhoea, but the pain and constitutional symptoms are seldom so well marked as in the ordinary acute middle ear suppuration.

In the earliest stages, before perforation takes places, the tympanic membrane may be covered with small tubercles which rapidly lead to multiple perforations of the membrane ; or the membrane may be yellowish pink in colour and is found to be bulging, and on touching it with a probe it may be found to be resistant owing to the tympanic cavity being filled with soft tubercular hypertrophied mucous membrane.

In the **chronic and more usual form** the course of the disease may be that of a simple middle ear suppuration from which, however, it can usually be distinguished by certain special clinical features. In a typical case of tuberculous disease of the middle ear the onset is painless, the chief subjective symptoms being a feeling of fullness in the head accompanied by tinnitus and a markedly increasing deafness. The discharge from the ear is slight, and may be intermittent and is sometimes sanious. Frequently it has a peculiar offensive smell, and is of such an irritating character as to cause eczema of the auricle. Enlargement of the cervical lymphatic glands, especially the preauricular, is characteristic of tuberculous disease of the ear.

Facial paralysis is by no means uncommon, occurring in about one-third of the cases. In a small child a painless chronic otorrhoea accompanied by facial paralysis is almost pathognomonic of tuberculous disease.

Objective Signs.—Multiple perforations of the membrane are typical of tuberculous disease. Frequently, however, the patient does not come under observation until these small perforations have coalesced, and have already given rise to considerable destruction of the drum.

Oedematous granulations lining the edges of the perforation are suspicious of tuberculous disease. Caries of the walls of the tympanic cavity, especially of the promontory and the region of the aditus and external semicircular canal, frequently occurs, and in many cases involves the facial nerve. There may or may not be external signs of disease of the mastoid process. In primary tuberculosis of the mastoid process, although a mastoid abscess may be present, there are usually no constitutional symptoms, nor pain, and on examination of the ear perhaps only a few granulations will be seen coming from the upper posterior part of the tympanic cavity.

Diagnosis.—A sudden diminution in hearing, which often seems out of all proportion to the pathological changes found within the ear is characteristic of tuberculous disease; it is frequently due to the involvement of the internal ear. The diagnosis is made from the foregoing clinical symptoms, the general appearance of the patient, the presence of some tubercular lesion elsewhere in the body, and the family history. It may be confirmed by examination of the discharge or of the granulation tissue for tubercle bacilli. Absence of tubercle bacilli in no way negatives the diagnosis. A more confirmatory test is inoculation of guinea-pigs.

Treatment.—Unless otherwise contraindicated the treatment is operative. The *complete mastoid operation* should be performed and all the diseased bone should be removed, if necessary freely exposing the dura mater and the lateral sinus. Special care should be taken to thoroughly curette away any granulations from within the tympanic cavity. If during the operation the disease is found to involve the cochlea or semicircular canals, they should be freely curetted; in these cases the fear of injuring the facial nerve has seldom to be considered, as it usually has already occurred as the result of the tuberculous process. After the operation the posterior wound should be left open. Any recurrent granulations should be removed and the site of their origin touched with a solution of pure carbolic or lactic acid.

In tuberculous disease, although there may be no external signs of involvement of the mastoid process yet, in spite of this, at the time of the operation extensive bone disease may be found. The mastoid cells are frequently filled with pale, oedematous granulations, and the bone may be so softened by caries that large portions of it can often be removed by means of the curette. When the tuberculous process extends to the dura mater it usually becomes very much thickened, and of a greyish nodular character. Curiously enough meningitis rarely occurs as the result of direct extension of the disease from the middle ear. If there is enlargement of the lymphatic glands they also must be removed.

If the general health of the patient is not good, especially in children, it is wiser to perform the operation in two stages. It is sometimes advised to remove the glands first, and afterwards perform the mastoid operation. It seems, however, wiser and a better surgical procedure to first remove the primary cause; that is, the diseased bone within the mastoid process. After the mastoid operation, the enlargement of the glands, which is often partially due to septic infection, may subside to a very large extent. They can then be removed, two or three weeks after the primary operation, under aseptic conditions.

Operation is only justifiable if there is no pulmonary disease or, when present, if it is in a condition of quiescence.

Operation is contraindicated if there is no prospect of cure owing to the general condition, or if there is active pulmonary disease.

Inoculation Treatment.—The inoculation of a tubercle vaccine, as laid down by Sir A. E. Wright, has in many instances proved of great service, and under certain conditions may be tried as a preliminary to operation. It is more especially indicated when the tuberculous lesion is limited to the ear, and when there is no active pulmonary disease. When both ears are simultaneously affected and the onset of deafness is rapid and extreme, without there being any extensive signs of disease, it is often a difficult matter to decide what to do. Theoretically the mastoid operation should be performed on both sides, but this is a severe measure from which the patient naturally shrinks. In such cases inoculation should be given a trial in the hope that even if it does not cure it may arrest the disease. Again, if the disease be localized to one ear with marked involvement of the cervical glands, very often, as the result of inoculation treatment, the glands rapidly diminish in size owing to the arrested tuberculous process. In any case the resisting power of the patient, as the result of this treatment, will be increased, and on this account he should be better fitted for operative treatment later on.

Prognosis.—A guarded prognosis should always be given owing to the fact that tuberculous disease of the middle ear is rarely primary, although at first it may appear to be so as it may be impossible to discover other tuberculous lesions. The prognosis is more favourable if the pulmonary disease is slight or quiescent, if the patient is in good health, if the bone disease is limited, and if there is no facial paralysis, no enlargement of the glands, and no involvement of the internal ear. If all the diseased bone can be removed a cure may be obtained. Unfortunately, however, in spite of an apparent cure, relapses are frequent either owing to minute particles of tuberculous disease being left behind or from reinfection. Death is rarely due to meningitis except when it occurs in the course of general acute miliary tuberculosis, but it is usually due to pulmonary disease or to general tuberculosis.

7. **Syphilis.**—The usual syphilitic lesions may be met with in the auricle and external meatus. Ulceration and gummata may give rise to deformity of the auricle or stenosis of the auditory canal.

As a sequela to inflammation of the tonsils and pharynx, *a simple* middle-ear catarrh or suppuration may occur.

It is doubtful whether there is any special tendency for the occurrence of chronic adhesive middle ear catarrh; but the occurrence of sclerosis of the middle ear in early youth, in the children or grandchildren of syphilitic parents, is considered by some as a syphilitic lesion.

Internal Ear Disease.—In the tertiary or late secondary stage the patient may become suddenly deaf within a few days after the onset; frequently this is accompanied by vertigo, tinnitus and attacks of vomiting, and is due to inflammation of the labyrinth.

In hereditary syphilis the same condition may be observed between the ages of sixteen and thirty, and is often accompanied by interstitial keratitis. The onset as a rule is not so violent in its symptoms as in acquired syphilis.

Treatment consists in the giving of iodide of potassium in large doses with injections of mercury. Politzer advises the hypodermic injection of a 2 per cent. solution of pilocarpine beginning with four minims and increasing the dose daily up to twelve minims.

Prognosis.—In acquired syphilis, if treatment is begun within a day or two of the onset it may be possible for partial or complete recovery to take place, but in congenital syphilis this is an extremely rare occurrence. Internal ear deafness is also possible as the result of gummata within the internal meatus, and may be associated with facial paralysis. Recently I had under my care a case of internal ear deafness and facial paralysis of syphilitic origin, in which rapid recovery was obtained from internal administration of iodides. The condition was presumably due to a gumma at the internal auditory meatus.

CHAPTER XIV

DEAFMUTISM

THE term deafmutism implies that the individual can neither hear nor speak. Speech is learnt by imitation of sounds. If the child is born deaf or becomes deaf at a very early age it is unable to hear and appreciate the varying sounds necessary for the production of speech, and so remains dumb.

Deafmutism may be congenital or acquired. It varies also in extent. Some deaf mutes are totally deaf to all sounds ; others may hear high notes or very loud sounds, although they cannot hear the voice.

Congenital Deafmutism.—This is less frequent than the acquired form. It may either be due to some deficiency in development of the auditory centre, or of the internal ear. As predisposing causes may be mentioned marriage between near blood relations such as first cousins, and heredity, which may show itself not necessarily in the first, but only in the second or third generation.

Acquired Deafmutism may be due to many causes, such as cerebro-spinal meningitis, acute specific fevers, especially scarlet fever and mumps, hereditary syphilis, and inflammations and injuries of the internal ear. Adenoid vegetations are a predisposing cause of deafmutism by causing middle ear suppuration in infancy.

If a child is born deaf it will remain dumb; if the hearing is lost between the ages of four and seven the child may possibly retain whatever speech it has already learnt, but, as a rule, owing to neglect, it gradually becomes inarticulate in its speech and finally dumb. If the deafness occurs after the seventh year of life it should be possible to retain the power of speech, although there is always a tendency for this to become indistinct unless great care is taken to make the patient articulate clearly.

Treatment.—If deafmutism is acquired, it is first necessary to remove any possible cause giving rise to the deafness. The nose, throat and ears should be carefully inspected. In some cases nothing abnormal is found, and the tuning-fork tests may show the presence of complete internal ear deafness. In other cases there are definite signs of old middle ear catarrh with retraction of the membrane, or old or recent middle ear suppuration. Usually in these cases the tuning-fork tests show that the internal ear is affected to a greater or lesser extent in addition to the middle ear affection. The ears should be carefully tested to determine the extent of the deafness. The Eustachian tube is then catheterized, and careful note made of the condition as to whether there is free entry into the middle ear or not, and whether there is any change produced in the appearance of the tympanic membrane by inflation. The hearing is again tested to see if there is any improvement in the hearing. In an infant or small child this procedure must be and vibrations of the larynx. The education of a deaf-mute is a very tedious and long process.

The children of the present time should be placed in a school for deaf mutes, or the [illegible] [illegible] the services of a nursery governess who has [illegible] a teacher of lip-reading should be obtained. Although deaf mutes may be taught how to speak and to know what is being said, owing to their inability to hear their own voice their tone of speech is frequently very monotonous and indistinct.

carried out under a general anaesthetic, and the mother should be told to determine for herself, at home, whether any improvement has taken place. If improvement does take place, the treatment of inflation should be continued. If adenoids are present they should be removed, and any inflammatory or suppurative process of the middle ear must be treated. If there is any remnant of hearing the patient should be tested with a speaking tube; it sometimes happens that words can be heard through it, and if the patient has previously been able to hear, much may be done by this means to educate his power of speech. It must be remembered, in testing deafmutes, that sometimes they seem to hear loud sounds such as slamming of doors and stamping of the feet on the floor; this, however, is due to concussion and not to hearing.

As internal medicaments strychnine may be given, and if there is any reason to suspect syphilis, mercury and potassium iodide. Unfortunately, it is usually too late for these measures to have any effect.

Education of Deaf Mutes.—There are two methods :—

(1) The **French method,** or speaking by signs and by the use of a finger alphabet.

This method has its limitations in that it enables the patient only to converse with those who understand the deaf and dumb alphabet.

(2) **The German or Oral method.**—The deaf mute is taught by means of lip-reading and by sense of touch. The pupil observes the movements of the lips and face of the teacher, and at the same time by placing his hand over the throat of the teacher feels the movements

and vibrations of the larynx. The education of a deaf-mute is a very tedious and long process.

The children of the poorer class should be placed in a school for deaf mutes; in the richer classes the services of a nursery governess who also is a teacher of lip-reading should be obtained. Although deaf mutes may be taught how to speak and to know what is being said, owing to their inability to hear their own voice their tone of speech is frequently very monotonous and indistinct.

CHAPTER XV

DISEASES OF THE NOSE AND NASO-PHARYNX IN RELATION TO DISEASES OF THE EAR

As has already been stated, nasal catarrh, nasal obstruction, or the presence of adenoids are most important factors in causing and maintaining middle ear inflammation or suppuration.

In the treatment of the nose, or in considering the question of removal of adenoids, the relation of the aural affection to these diseases must first be carefully considered.

When there is a definite history of increasing deafness or attacks of earache or middle ear suppuration occurring as a sequela of nasal or post-nasal catarrh, conservative or operative treatment on the nose becomes necessary. When, however, in the course of a chronic middle ear catarrh or otosclerosis, only a slight obstruction of the nose is accidentally discovered, operative treatment is unjustifiable, especially if the post-nasal space appears healthy and the Eustachian tubes patent.

Nasal Obstruction.—The nasal obstruction may be due to some acute transient catarrh or to some more permanent chronic condition. Frequently the catarrh begins in the nose and spreads backwards, involving the ear. During the stage of acute middle ear catarrh or inflammation only the simplest measures should be carried out.

Treatment.—A nasal douche should not be given. It is sufficient to prescribe an inhalation of menthol as follows:—

Menthol	ʒi
Ol. Cassiæ	♏v
Spt. Vini. Rect.	℥i

S. Two or three drops to be poured into a pint of water at 140° *Fah. and the steam to be inhaled through the nose.*

Or the nose may be frequently sprayed by means of an atomiser with the following oily solution :—

Menthol	gr. 5
Camphor	gr. 3
Oil of Eucalyptus	♏. 5
Ol. Amgydal. Dulc.	℥i.

If the congestion of the nose is very great, temporary relief may be obtained by using a spray containing a small quantity of adrenalin and cocaine.

Where there is a general slight catarrh of the mucous membrane of the upper respiratory tract, the use of an Ammonium Chloride Inhaler may be of considerable benefit. It consists of a solution of hydrochloric acid and ammonia whose fumes are brought together in a bottle, and the nascent ammonium chloride is inhaled into the mouth and exhaled out of the nose. In some cases considerable relief is experienced by filling the mouth with the vapour, and then doing Valsalva's method of inflation; but the patient should be warned not to do this too frequently. After the acute nasal and middle ear catarrh have passed off, if the nasal obstruction still continues, the nose should be carefully inspected. The obstruction may be due to a chronic swelling of the mucous membrane of the turbinates, especially of the posterior extremities of the inferior turbinates; to deviation of the septum; to a septal spur; to a combination of these conditions; or perhaps to the presence of nasal polypi.

The treatment depends on the condition found. If there is simple rhinitis accompanied by post-nasal catarrh and much phlegm at the back of the throat, the ordinary alkaline nasal douche or a solution of either listerine, glycothymolin, or formolyptol, one part in eight to ten of warm water, may be given.

If there is no improvement, in spite of this treatment having been conscientiously carried out for two or three weeks, the nose should again be examined. Pledgets of wool soaked in a 1 in 2,000 adrenalin solution containing 5 per cent. of cocaine should be inserted into the nose and left *in situ* for at least ten minutes. The effect of this solution is to diminish the vascular turgescence; but if the condition is one of chronic hypertrophy with thickening of the submucous tissue it will not be so affected.

If the swelling is due to simple vascular turgescence it may only be necessary to cauterize the surface of the mucous membrane of the inferior turbinates. If however, the obstruction is due to chronic hypertrophy, or to the presence of a spur or polypi, further operation may be necessary.

Enlargement of the posterior ends of the inferior turbinates is one of the most frequent causes of post-nasal catarrh, and therefore an important factor in maintaining the middle ear trouble. They should, therefore, be always removed. This procedure is best carried out by means of a snare either with or without a general anaesthetic, but the cocaine and adrenalin solution should not be used, as it will cause shrinkage of the mucous membrane, and render the operation difficult, if not impossible.

Adenoids are found in the earliest years of life and may even be congenital. They are by far the most common cause of middle ear disease in childhood. Their general symptoms and after effects are now well known, and need not here be described except in so far as they relate to the ear.

In a child adenoids should be suspected if nasal obstruction is accompanied by intermittent attacks of deafness, earache or otorrhoea. With adenoids is often associated enlargement of the tonsils. On examining such a case there is either marked retraction of the drum or signs of middle ear catarrh and inflammation, or there may be a perforation which is usually situated in the antero-inferior quadrant. The presence of adenoids predisposes to middle ear disease in that they cause inflammation of the mucous membrane of the post-nasal space which by extension involves the Eustachian tube.

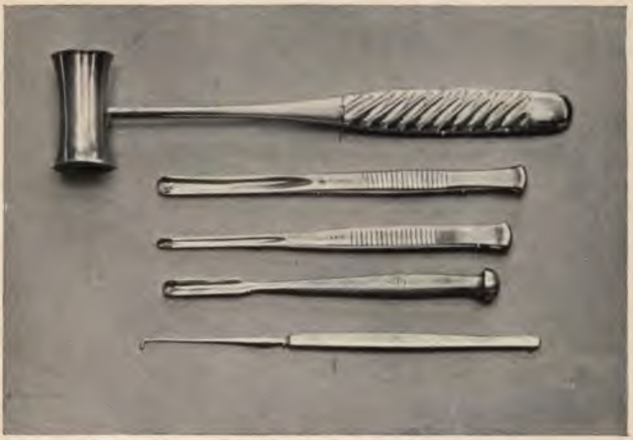
The **treatment** depends on the condition found. If there has been merely a slight attack of middle ear catarrh and the nasal respiration is as a rule free, and if the pad of adenoids is small, operative treatment is not necessarily indicated. The child should be taught to breathe through the nose, and to encourage this " breathing exercises" should be given. If there is much secretion from the nose, a mild alkaline nasal douche lotion should be given daily until the normal condition is restored. The mother should be warned to watch the child, paying special attention with regard to the occurrence of deafness, or any other symptom of middle ear catarrh. If this occurs in spite of simple conservative treatment, operation will become necessary. Of internal medicaments the most efficacious is a mixture containing equal parts of the compound syrup of phosphates of iron and iodide of iron, of which a teaspoonful may be given three times a day.

If there is obviously a large pad of adenoids causing definite nasal obstruction in addition to middle ear disease, operation should at once be advised.

Operation is contraindicated during the period of acute middle ear inflammation and suppuration; it should only be done after the acute attack has subsided.

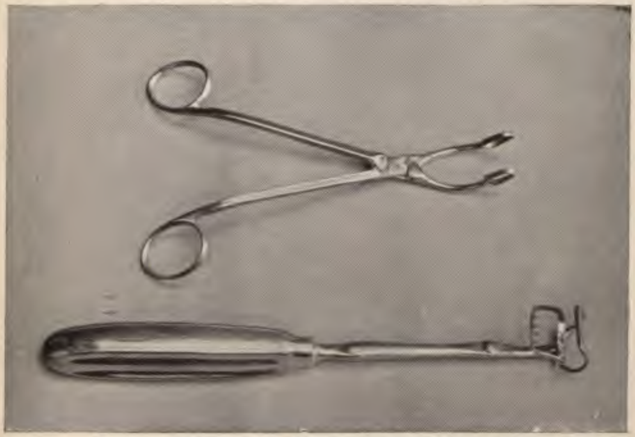
The operation is a simple one, and after a little experience is easily performed. If there is enlargement of the tonsils, they should be removed at the same time. The danger of haemorrhage, as a result of this operation, is exaggerated; it very rarely gives any cause for anxiety. The adenoids may be removed either by means of a curette or forceps (*see* Plate XVIII). Both instruments are of service.

Technique of Operation for removal of Adenoids.—The operation should be performed under a general anaesthetic, preferably A.C.E. mixture. In performing the operation the patient should lie on the operating table on his back. It is not necessary for the head to hang over the edge of the table. The



INSTRUMENTS FOR MASTOID OPERATIONS.

1. Hammer. 2, 3, 4. Gouges. 5. Seeker.



INSTRUMENTS FOR REMOVAL OF ADENOIDS.

1. Forceps. 2. Curette.
(St. Clair Thomson's pattern.)

[*Plate XVIII.*

operator stands on the right-hand side of the patient; the anaesthetist places a gag in the left side of the mouth and holds it in position, at the same time supporting the head with his hands. A nurse stands on the left of the patient, ready to turn the patient over when necessary. After exploring the post-nasal space with the finger to determine the size of the pad of adenoids, the curette is introduced and is rapidly passed behind the palate, care being taken that the uvula is not pressed up in front of it. The curette is then pulled forward against the soft palate to make certain that it is in front of the adenoids and behind the palate. The handle is then pressed downwards against the teeth of the lower jaw at the same time raising the cutting edge of the curette so that it rests against the roof of the post-nasal space. The curette is then pushed backwards, thus cutting through the upper attachment of the adenoid growth. The handle is then raised with a sweeping movement up against the incisor teeth of the upper jaw; this movement is continued in an upward direction so that, with the upper teeth acting as a fulcrum, the cutting edge of the curette is brought downwards so as to cut through the posterior and lower attachment of the growth. As a rule the pad of adenoids comes away *en masse*. For a moment or two there may be free haemorrhage, during which period the nurse and the anaesthetist turn the patient well over on to his right side. Whilst the patient is in this position, the surgeon may feel with his finger if all the adenoid tissue has been removed. If not, after the blood has been rapidly mopped out of the mouth, the patient is partially turned again on to his back, and with the forceps the remaining adenoid tissue is quickly picked away. During the operation care must be taken that the patient is not too deeply anaesthetised, so that the power of reflex swallowing remains, in order to prevent blood getting into the larynx. The best method to arrest haemorrhage after the operation is to sponge the face with ice-cold water.

The after-treatment consists in keeping the patient quiet for two or three days in a room of even temperature, if necessary only giving light diet. *Local treatment such as syringing of the nose is to be avoided.*

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